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Impacts of the Conservation Reserve Program in the Great Plains

Symposium Proceedings

September 16-18, 1987

General Technical
Report RM-158

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SOIL CONSERVATION SERVICE

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General Technical Report RM-158

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John E. Mitchell, editor

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Foreword

During the 1986 Winter Meeting of the Colorado Section, Society for Range Management (SRM), several individuals suggested a need for involvement by the Section in examining the Conservation Reserve Program (CRP) contained in the Food Security Act of 1985. We were primarily concerned about the potential ramifications of the CRP on rangelands and their management during the next one or two decades. These were deemed to be quite significant from both a management and socio-economic viewpoint.

It is important to examine the CRP in terms of its ramifications on soil conservation, agriculture, and society. Next to the Payment in Kind Program, the CRP has the potential to be the most expensive USDA program in history. Nonetheless, Congress, in passing the Act, has recognized the value to the United States of taking erodible land out of crop production. These tax funds are only well spent, however, if much of this land is maintained under a permanent cover after the 10-year rental periods end. Hence, billions of dollars could, and will, be wasted if interested individuals, organizations, and agencies do not use these few intervening years to work towards such an end.

Passage of the CRP resulted from an unlikely coalition of agricultural interests and the environmental movement. The former were primarily concerned about the widespread economic crisis in farming that had resulted from many factors; decreasing land values, low commodity prices, high interest rates, etc. Environmentalists, on the other hand, were willing to support a program that would substantially decrease soil erosion and improve wildlife habitat. It is important to recognize the intrinsic instability of alliances involving groups with little in common, as the CRP is evaluated.

Papers in these Proceedings focus primarily on issues concerning the Great Plains. It is logical to do so for several reasons: (1) early conservation acts were implemented as a result of the Dust Bowl, (2) plowouts of very large blocks of land during the past 10 years were concentrated in the Great Plains, (3) problems precipitating the recent farm crisis appear most severe across Great Plains states, and (4) much of the land base entering the CRP during early signup periods was concentrated in this area.

The opportunities and problems addressed in most papers, however, apply equally to other parts of the U.S. Specific practices, along with recommended species and cultivars to be planted, may differ from those described in this Proceedings. From a farmer's perspective, however, the same basic issues affecting his or her decision to enter the CRP, as well as what kind of permanent cover to plant, apply in every region. Economic and social problems encountered by rural communities impacted by the CRP may well be as common to counties in the Southeast as among those in the West.

The fundamental reason for holding the CRP Symposium and publishing these Proceedings is not to restate historical events or describe the current situation. Their principal importance is in directing a look ahead at the uncertain future, to stimulate thinking about courses of action that will enhance opportunities for achieving the stated goals of the CRP. Secretary Wilson Scaling of the Soil Conservation Service provides focus to the need to foresee shortcomings in legislation and policy in his paper.

Those charged with providing information to farmers and others directly associated with the CRP, as well as those who advise legislators and policymakers, have pivotal roles in the effort to maintain the goals of this Program. Some questions, unfortunately, cannot be addressed if needed research is not funded. Examining research gaps constitutes another way of looking ahead.

Acknowledgement is due one of the Symposium sponsors, the Farm Foundation, for providing a grant to help pay the travel of invited speakers. Many members of the Colorado Section and Denver Office of SRM assisted in the planning and accomplishment of the CRP Symposium, without which this report would not exist. Particularly worthy of mention are Harold Goetz of Colorado State University and William A. Laycock of the University of Wyoming for jointly producing the program. Finally, special thanks are due to Marjorie Swanson, who spent many hours proofreading each manuscript, cross-checking literature citations, and supervising production control, and Karen Omeg for assisting her.

We thank the authors for supplying their papers in electronic form, which helped speed their publication. The opinions expressed are those of the authors, and do not necessarily reflect the opinions or policies of the U.S. Department of Agriculture.

The Conservation Reserve Program: A Perspective

Harold Goetz[1]

Abstract.--The Conservation Reserve Program (CRP) has substantially influenced the nature of agriculture in parts of the United States, including the western Great Plains. It has a potential for even greater influence in future years, depending upon policy and funding. Many of these impacts are still unknown. However, the long term outlook for land use and management under the CRP is positive for those operators who survive the short term perturbations.

It is a great honor and privilege to be here today as a participant in this historic event. This regional symposium is concerned with the many difficult aspects and impacts of the Conservation Reserve Program (CRP). I believe our gathering here to be a benchmark for future decisions and directions this Program will take during the first 10-year period; and undoubtedly, the collective wisdom developed by this assembly of experts will translate into future management policies for all affected natural resources. You are the vanguard for this effort which involves 40-50 million acres of farmland and an unknown number of farm families and businesses.

The CRP is not just another farm program to aid an industry to overcome difficult financial circumstances on a short-term basis. While one of the CRP's consequences certainly is continuity of farmers income, its primary objectives are reducing soil erosion and, thereby, sediment and other pollutants in streams and rivers, protecting fisheries and water treatment systems, preserving soil productivity, providing wildlife habitat, and reducing surplus commodities. While similar farm programs have had some of the same objectives, none have had the potential impact and lasting effects of this program. There are a number of reasons why I believe this to be true.

Previous farm programs have not required, at implementation, a conservation plan which ensures an element of compliance by the landowner if he or she is to share in the revenue derived from the 10-year plan. Another requirement is that only the most erodible land is eligible for this program. Highly erodible land is more likely to remain in permanent cover. It is assumed that there will be no economic incentive to return these lands to annual crop production at the end of the 10-year period, which would restart the cycle of increased soil erosion and add to the continuing surplus of agricultural products. The economic reality of this situation is simply one of low prices and continued financial stress for farmers, continued loss of a valuable natural resource (soil), and the negative impacts on other resources.

An opportunity exists to redirect present land uses to other activities after the 10-year period has expired. The development of multi-species grazing industries certainly must become part of the replacement for the present cereal grain industries. Planting a variety of grasses on the reserve acreages assures the operator of the needed combination of plants to enter into a grazing industry capable of accommodating this approach. Another aspect of this will be the potential development of wildlife habitat that could provide opportunities for fee hunting as another source of income for many operators. Other limited activities which may generate income for some operators include hiking, bird watching, camping, and horseback riding.

The federal government, as advocate for society at large, may be directed to continue this program in perpetuity to ensure the protection and enhancement of the soil and other impacted resources. I believe it is ethical and appropriate that we, as a society, pay the costs of this type of conservation of natural resources. The investment is ultimately more logical and sound than to support policy which can plunder the land through soil erosion, aggravate the surplus situation, thereby reducing farmers' incomes, and generate a repeat of a cycle which has no acceptable or permanent solution.

Perhaps the largest unknown impact of this program is the magnitude of an anticipated negative effect on rural farm communities. The reduction of the demand for agricultural services is, indeed, serious. The immediate loss of cash flow from the purchase of fuels, fertilizer, seeds, etc., and the reduced need for local farm labor and bank loans becomes problematic and may well result in the loss of certain private enterprises that are solely reliant on local sales. On the other hand, for a number of well

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established credit-worthy operators the assurance of a known amount of cash each year for a decade may be the collateral needed to continue to obtain bank loans to operate the portion of the farm or ranch not included in the CRP. This money will also translate into economic activity at the rural level, depending upon the level of purchasing by the operators remaining in business.

The sociological dimension is another aspect: To what extent will communities change in terms of consolidation of farms and loss of families, lack of opportunities to begin or continue farms and associated support businesses, or the inability of operators to form workable partnerships? The very nature of rural economic communities will, perhaps, continue to result in a decline of numbers regardless of the CRP. The decline in farm families is a phenomenon that started after World War II when new technologies allowed for the gradual replacement of intensive farm labor. The Soil Bank Program in the 1950's, the largest land retirement program to date, resulted in a substantially reduced operator pool, and the number of farm operators has continued to decline. Now, the CRP has the potential of further reducing the remaining operators.

Despite the conceivable negative effects from this program, I believe the positive long-term benefits to society will prevail. I have already touched on what I believe will be negative impacts on a short-term basis. The long-term outlook is one of optimism for the future of the farming-ranching industry, for those who survive the initial restructuring from the Program. I believe it is logical to expect larger, more efficient farms and ranches in the future. There will be more cooperative ventures between those who own the land and those who lease from or are in a partnership with the landowners. Managers will be skilled in the application of modern technology such as computers, modeling, remote sensing, and fiscal control. The ultimate objective will be to protect and manage the renewable natural resources in a manner consistent with sustained systems integrity, efficiency, and maximum net dollars.

I believe we, in this assembly, can be a viable and effective force in directing present policy and shaping future policies and programs so that farm/ranch operators, professional resource managers, and the general public support the transition of land use changes to enhance natural resource management for the benefit of future generations.

History of Grassland Plowing and Grass Planting on the Great Plains

W. A. Laycock[1]

Abstract.--Plowing on the western plains started in the 1880s. First attempts to stop erosion by planting grasses came after the Dust Bowl (1930s). During the Soil Bank Program (1956-1969) 14.1 million acres of grassland were planted. These lands were re-plowed along with more than 4.5 million acres of previously unplowed grasslands in the 1970s and early 1980s.

This paper deals with some of the historical aspects of land use on the Great Plains of the United States.[2] The Great Plains, as defined in this paper, are the treeless steppes of North America that lie west of the 98th Meridian and east of the Rocky Mountains and extend from northern Mexico into southern Canada. The climate is semiarid to subhumid. The Great Plains were called "The American Desert" during much of the nineteenth century, a name that was prophetic of the conditions during the drought of the 1930s. Much of this paper will deal with the western and more arid part of the Great Plains nearest the mountains and generally receiving 15 inches or less of precipitation. The native vegetation of this area is dominated by shortgrasses and midgrasses.

The first human inhabitants of the Great Plains were the nomadic and non-agricultural Plains Indians who depended on game for food. The native grazing animals included the bison and pronghorn antelope, both of which were present in large numbers.

Settlement

Spanish explorers come into the plains in the sixteenth century and, during the latter part of the seventeenth century, established missions in southern Texas. However, they had little influence in the Great Plains. Parts of the Great Plains were explored by Lewis and Clark (1803-1806), Pike (1803-1807), and Long (1819-1820). Until about 1830 explorers, fur trappers crossed the Great Plains to get to the foothills and mountains in search of beaver.

Starting in the 1840s, many travellers passed through the plains heading for somewhere else. Travellers on the Oregon Trail followed the Platte and North Platte Rivers in Nebraska and Wyoming starting in 1841. In the late 1840s, the same trail across the plains was used by the Mormons heading for Utah and by the gold miners heading for California. It is estimated that 350,000 people came across this trail in Wyoming from 1841 through 1866 (Dorn 1986).

The cattle industry had become well-established in Texas in the early nineteenth century. Cattle numbers in Texas increased rapidly, but marketing the stock was a problem. Following the Civil War, the railroads were extended west of the Missouri River. The great trail drives taking Texas cattle northward began in 1876 when cattle were driven to the railhead at Abilene, Kansas, to be shipped to Chicago and other eastern cities. As the railroads continued westward, so did the shipping points. Between 1867 and 1880, over 4 million cattle were trailed north to the railroads in Missouri and Kansas and shipped to the East (Webb 1931).

The first cattle came to the western part of the northern plains in 1866 when Charles Goodnight and Oliver Loving brought 1000 cattle through New Mexico on the Goodnight-Loving trail and sold them to John Wesley Iliff near Greeley, Colorado. The 1860s and 1870s was a period when large ranching operations were formed through the use of foreign capital (mostly English and Scottish) and "free" grass on the public domain lands. In northeastern Colorado, Iliff owned only 15,000 acres but, by virtue of controlling access to water, he dominated the whole northeastern part of Colorado and ran 35,000 cattle. The Prairie Cattle Company, a British company, controlled over 5 million acres in Colorado, New Mexico and Oklahoma and owned

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[2]The early history was drawn largely from McGinnies, W.J., and W.A. Laycock (In Press), The Great American Desert--Perceptions of Pioneers, The Dust Bowl, and The New Sodbusters, a paper presented at the Arid Lands Research Development Conference in Tucson, Arizona in October, 1985.

140,000 cattle (Steinel 1926). There were many other such ranching operations throughout the Great Plains. Cattle numbers in the Great Plains states increased from 1.1 million in 1870 to 4.4 million in 1880 to 8 million in 1886 (U.S. Senate 1936).

Mild winters had prevailed on the plains in the 1860s through the mid 1880s when this rapid expansion took place. However, the winter of 1885-86 on the southern plains was extremely severe and the following winter was also quite severe on the northern plains (Mitchell and Hart 1987). During these two years, hundreds of thousands of cattle either froze or starved to death. This, coupled with drought and a drastic decline in cattle prices, helped end the days of the vast cattle empires on the plains.

Another factor which influenced the decline of the cattle industry was the arrival of homesteaders in the western part of the plains. Congress had passed the Homestead Act in 1862. It allowed a person to take possession and farm 160 acres. The better lands in Iowa, Missouri, Kansas, Nebraska and other eastern plains states were homesteaded first. There, 160 acres was sufficient to make a living. In the western plains much of the land and the climate were not suited to farming, and 160 acres was insufficient to support an individual farmer and this family. However, large numbers of homesteaders started to reach the western Great Plains by the mid 1880's.

The transcontinental railroad across Nebraska and Wyoming was completed in the late 1860's. In the 1870s and 1880's other railroad lines were pushed into many parts of the western plains. Most of the railroads received a government subsidy in the form of land. The railroads were anxious to sell this land to settlers in order to raise capital and to provide a steady passenger and freight revenue. Land was also available for the settlers to homestead. To entice settlers to move to the Great Plains, it was first necessary to dispel the myth of the "Great American Desert." Promoters, called "Land Boomers," made extravagant claims about the productivity of these lands. They claimed that "rain follows the plow"; i.e., as soon as people started farming, more rains would come. Reports of exceptional crop yields (obtained during very favorable years) were widely reported in the Eastern press. Such high yields often occur immediately after sod is broken because of the initial availability of nutrients.

By 1890, 6 million people were living on the Great Plains, most who had come after 1886. Between 1880 and 1899, 104 million acres on the plains were plowed for crop production (U.S. Senate 1936). Wheat grown under dry land farming techniques has been the primary crop since the 1890's.

Shantz (1956) reported that, by 1908 in eastern Colorado, only 13% of the land had been plowed. When he again surveyed this same area in 1949, 96 percent of the land had been plowed. Most of the new plowing was done from 1915 to 1925 to grow wheat needed during World War I and the economic expansion that followed. It was also during this period that large-scale mechanization came to the wheat-growing areas of the United States. This permitted an individual farmer to raise crops on much more land. All of this plowing had a major effect on the severity of the dust storms during the Dust Bowl period.

The Dust Bowl, 1931-1936

The history of the Dust Bowl has been well documented. Of particular interest are recent books by Worster (1979) and Hurt (1981). Hurt (1981) pointed out that there were many severe dust storms before those of the 1930's. Dust storms were reported in 1830, 1854, 1860-1864, 1874-1878, 1886-1888, 1892-1893, 1895, 1901-1904, and 1912-1914. Shantz (1956) observed that, while there had been dust storms, there was no Dust Bowl until the native sod was destroyed by the plow.

In the United States, starting in 1931 and continuing until 1936, precipitation throughout the plains was extremely low. In some years the native grasses did not even green up and crops routinely failed. By 1933 almost any wind was creating dust storms from fields bare of crops (Hurt 1981). The major dust storms occurred in 1934 and 1935, some of which reached the east coast and out over the Atlantic Ocean. One such storm in May 1934 was cited by Hugh H. Bennett, first Director of the Soil Conservation Service, as a turning point in arousing public awareness of the problem:

> "This particular dust storm blotted out the sun over the nation's capital, drove grit between the teeth of New Yorkers, and scattered dust on the decks of ships 200 miles out to sea. I suspect that when people along the seaboard of the eastern United States began to taste fresh soil from the plains 2,000 miles away, many of them realized for the first time that somewhere something had gone wrong with the land.... it took that storm to awaken the nation as a whole to some realization of the menace of erosion."

These dust storms spurred a formerly apathetic government into action. The Bankhead-Jones Act was passed in 1935, one portion (Title III) of which authorized the government to buy submarginal land that was not capable of supporting a family. Land Utilization Projects were established throughout the western part of the Great Plains as models for proper grassland agriculture. Many of these plowed lands were seeded to perennial grasses while others were allowed to return to a grass cover naturally through the process of secondary succession. These Land Utilization Projects were administered by the newly created Soil Conservation Service from 1938 until 1954. In 1954 most of these lands were turned over to the Forest Service and are now known as National Grasslands.

The New Sodbusters

During the period following the Dust Bowl, conservation practices were developed and put to use. In the 1940's, a decade of generally favorable precipitation, some additional land was plowed for wheat production, a result of the needs of World War II and the desire to take advantage of the high wheat prices in the post-war period. An intensification of plowing of previously unbroken grassland began in the mid 1970's after the historic Russian wheat sale of 1972 and continued into the 1980's.

National attention of such activity did not come until the spring of 1982 when a Canadian farmer purchased approximately 15,000 acres of rangeland in Weld County in northeastern Colorado and proposed to plow it (Steinmark 1983). The county commissioners, worried about the consequences, first tried unsuccessfully to get the state to intervene, then finally passed an emergency ordinance prohibiting plowing of grassland that had not been plowed in the past 5 years without a permit. Unfortunately, the 15,000 acres in question had already been plowed by the time the ordinance was passed.

This particular plowing incident and the legal action by Weld County drew national television and newspaper coverage and prompted widespread concern in Colorado and other states. Several other counties in Colorado and at least one county in Montana have adopted laws patterned after the Weld County legislation to try to prevent unwise destruction of native grassland. The Weld County incident was only one example of what had been happening in the previous years throughout eastern Colorado and in other plains states such as Montana (Walcheck 1983) and Nebraska (Aucion and Pierce 1983).

Approximately 4.5 million acres of previously unbroken grassland have been plowed during the recent past in the central and northern Great Plains (table 1). The greatest amount of plowing has been in Montana with 1.8 million acres plowed between 1977 and 1982. Newly plowed land in North Dakota (849,000 acres), South Dakota (750,000 acres), and Colorado (572,000 acres) make up the bulk of the additional area plowed (Laycock and Lacey 1984). Much of this was in land capability classes IVe, VI and VII.

In 1983, by far the greatest amount of grassland plowing activity was in Montana. The total acreage plowed in 1983 is not known, but was estimated to be 250,000 acres. Some very extensive areas plowed in solid blocks received widespread publicity. For example, one operator plowed a large part of the 50,000 acre Crow Rock Ranch in Garfield and Prairie Counties, and another plowed about 25,000 acres of 2 ranches in Petroleum County. Much of this plowing was done in solid blocks, miles on a side, filling in gullies and waterways (Walcheck 1983, Crummett 1983). By 1984 declines in land prices and low wheat prices had stopped much of the plowing, at least on such a large scale.

Table 1.--Area of previously unplowed grassland in the northern and central Great Plains, plowed in the 1970's and early 1980's. Figures are estimates from the Soil Conservation Service in each state.

State	Area (thousand acres)
Colorado	572
Kansas	15
Montana	[1]1,842
Nebraska	400
North Dakota	849
South Dakota	750
Wyoming	71
Total	4,449

[1]Land plowed through 1982. An additional 250,000 acres was estimated to have been plowed in 1983, but cannot be substantiated.

Very little grassland would have been plowed if there were no economic incentives to do so. Of primary importance has been the depressed state of the cattle industry. Cattle prices have been and remain low, and many cattle raisers have lost money on their operations for a number of years. Until recently, a great many ranchers had stayed in business only by using steadily increasing land values as collateral for loans for operating capital.

The loan value of the land stimulated some of the plowing (Huszar and Young 1984) because farm land was worth two to three times as much per acre as rangeland with little regard for the long-term productive capacity of the land or the erosion hazard. In fact, some plowing apparently was forced by banking or agricultural lending organizations insisting that certain lands be plowed in order to qualify for loans. Some of this type of plowing to increase land values was done by individual ranchers or farmers, but more often it was done by speculators, at least in the late 1970s and early 1980s. In the last several years, drastically decreased land prices have temporarily taken the speculators out of the picture.

In addition to the economic factors discussed above, government agricultural support programs have played a major role in grassland conversions (Walchek 1983). Crop price supports, crop insurance, disaster payments, Farm Home Administration loans, land set-aside payments such as the Payment in Kind program (PIK), and storage loans enhanced the expected returns from grasslands converted to crop land and accelerated the plowout. It is at these federal subsidies that Sen. William Armstrong (R-Colorado) aimed his "sodbuster" bill, which passed the Senate in 1982 and again in 1983 but failed to pass in the House in both years. Different versions of the "sodbuster" bill passed both houses of Congress in 1984. However, the conferees could not agree and the legislation died. The Food Security Act (FSA) of 1985 contained "Sodbuster" and "Compliance" features and also provided for a "Conservation Reserve" which would pay farmers for putting highly erodable land back to pasture or other permanent vegetation.

Efforts to Revegetate Plowed Lands

The first major effort to replace perennial grasses on plowed land on the Great Plains came after the Dust Bowl. By 1951, 0.9 to 1.1 million acres were seeded on the almost 6 million acres of the Land Utilization projects in 12 states (from undated and unpublished file report "Policies Regarding Conservation and Development and Use of Land Utilization Project Lands Administered by the Soil Conservation Service"). No record was found of the species used or success of the seedings. Entire Land Utilization Projects were put under proper grassland management and the lands have been retained in Federal ownership preventing any replowing. Except for those in Montana, the Land

Utilization lands were turned over to the U.S. Forest Service in 1954 and have been administered as National Grasslands (table 2).

Most information concerning the drought of the 1930's has focused on the Great Plains of the United States. Gray (1967) published a book "Men Against the Desert," which outlined what happened in the Palliser Triangle of Alberta, Saskatchewan and Manitoba in Canada. The drought started earlier in this area than in much of the United States and crops first failed in 1929. The drought prevailed into 1936 with record high temperatures recorded in 1931, 1934, and 1936. The Prairie Farm Rehabilitation Administration (P.F.R.A.) was formed in 1935 to rehabilitate the land and put it back into grazing use. At least one million acres were seeded to perennial grasses, mainly to crested wheatgrass *(Agropyron cristatum)*. The seeded and intermingled natural prairie area were fenced into "community pastures." This fenced land totaled 1.0 million acres by 1942, 1.4 million by 1948 and 2.3 million by 1965. These lands are still administered and managed by P.F.R.A., and grazed by local ranchers organized into cooperatives.

The use of shelterbelt planting constituted another approach to prevent erosion during and after the drought of the 1930's on the Grain Plains. In 1934 the federal government proposed to plant windbreaks in a strip 100 miles wide south from the Canadian border to Oklahoma. The first shelterbelt was planted in Oklahoma on March 18, 1935 (Anonymous 1986). By 1942, when much of the effort was completed, 223 million trees had been planted on 30,000 farms and ranches. (Anonymous 1986). These shelterbelts stayed in place, for the most part, until the mid-1970's when farm and machinery size expanded and the shelterbelts began to be viewed as "in the way" of both machinery and the new center-pivot sprinklers. The specter of an another drought had been forgotten or disregarded, and a great many of the shelterbelts were removed and maintenance of many of the other was discontinued. Thus, the trees and shrubs that had been planted with government subsidies were removed to grow more crops which were subsidized by the same government.

Table 2.--Area of Land Utilization Lands which became National Grasslands (from Rowley 1985).

State	Area (thousand acres)
Montana	[1]1,900
North Dakota	1,105
South Dakota	864
Colorado	612
Wyoming	573
New Mexico	134
Texas	117
Kansas	107
Oregon	103
Nebraska	94
Idaho	48
Oklahoma	47
Total	5,704

[1]*Lands in Montana were turned over to the USDI Bureau of Land Management. All other lands became National Grasslands administered by the USDA Forest Service.*

Table 3.--Land area in Soil Bank Program in the Great Plains at its peak (1960-1961) and total cost (1956-1969).

State	Land area (Thousand acres)	Total cost (million $)
Colorado	1,300	91
Kansas	1,450	136
Montana	630	46
Nebraska	880	72
North Dakota	2,705	209
Oklahoma	1,494	123
South Dakota	1,822	140
Texas	3,667	299
Wyoming	125	8
Total Great Plains	14,073	1,124
Total U.S.	28,661	2,477

The first major effort to get perennial cover planted on plowed private land was the Conservation Reserve Program established in 1956 under the Soil Bank Act. The primary purpose of the program was to divert land from crop production. The secondary purpose was to establish and maintain protective vegetative cover (trees, perennial grass, etc.) on the land taken out of crop production (undated and unpublished file report, Soil Conservation Service "Final Report, Conservation Reserve Program, Summary of Accomplishments, 1956-1972).

The Soil Bank was a voluntary program. Each participating farm signed a contract to withdraw a designated area of cropland from production for 3 to 10 years. Other agreements were to; (1) comply with any acreage allotments, (2) reduce the total cropped acreage by the amount placed in the reserve, and (3) provide and maintain approved conservation cover on the reserve land. The farmer was eligible for cost sharing for establishment of the conservation cover and received annual rental payments to compensate for the loss of income on the acres retired.

At the peak of the program in 1960 and 1961, there were more than 306,000 farms with approximately 28.7 million acres under contract (table 3). About half of these acres (14.1 million) were in the Great Plains and most of these were planted to perennial grass. Total cost of the program was $2.48 billion for rental payments and $162 million cost sharing for establishment. The average annual payment was $11.85 per acre. and the average total payment for the life of the program was $86.43 per acre. All contracts had expired by the end of 1969.

It appears to be debatable whether the primary purpose of the Soil Bank, i.e., to divert land from crop production, was achieved. Figure 1 shows the acreage enrolled in the Soil Bank Program and the total acreage of wheat in the Great Plains. It is assumed that most of the land put into the Soil Bank in the Great Plains were wheat lands. The Soil Bank does not appear to have

resulted in a substantial drop in the acres of wheat planted in the plains. The drop in wheat acreage in 1957 may have resulted more from a separate voluntary Acreage Reserve Program in 1956-58 that paid farmers not to grow crops. This Acreage Reserve Program idled about 11 million acres on the Great Plains in 1957. There were similar cropland set-aside programs in 1969-1972 for 12-20 million acres each year. These tended to reduce wheat acreage during the period when the Soil Bank contracts were expiring.

The secondary purpose of the Soil Bank, i.e., to establish and maintain protective vegetation, also failed in the long run, at least on the Great Plains. A fairly dramatic increase in wheat acreage starting in 1973 resulted in most Soil Bank lands being plowed and was at least partially a response to prices. Wheat was selling for about $1.80 per bushel in 1972. A large wheat sale to Russia pushed prices to more than $4.00 a bushel in 1973 and 1974. By 1977 prices had fallen to $2.30 per bushel and this, coupled with new set aside programs in 1978 and 1979, again reduced wheat acreage. The drop in acreage in 1983 (fig. 1) appears to be a result of the PIK (Payment in Kind) Program.

It appears that the Soil Bank Program was successful as a conservation measure only during the life of the contracts. Although data are not available, experienced observers have indicated that, on the Great Plains, almost all of the cropland planted to grass in the Soil Bank Program were plowed again in the early 1970's or later. Thus the $2.6 billion spent ($86 per acre under contract) was not effective as a long-term conservation measure. Although much more difficult to determine, it also appears that the Soil Bank had little immediate or long term effect on the reduction of acreage planted to wheat.

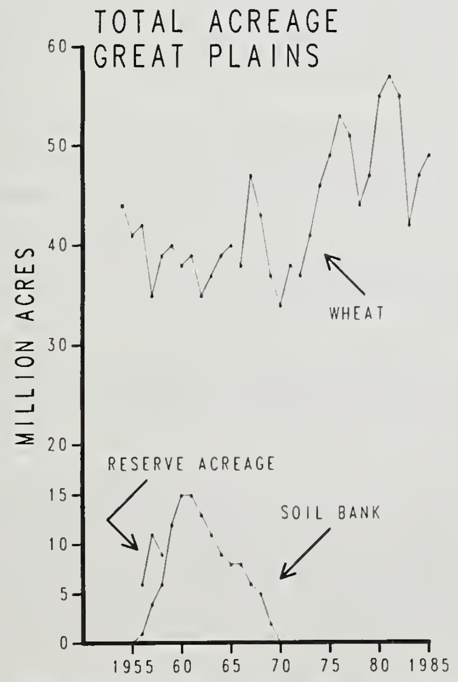

Figure 1.--Total acreage of wheat on the Great Plains and amount of land in the Soil Bank, 1956-1969.

Table 4.--Great Plains range and pasture lands identified as having high and medium potential for conversion to cropland in the next 10-15 years (Hexem and Krupa, 1987).

State	Area (thousand acres)
Northern Plains (ND, SD, NE, KS)	20,397
Southern Plains (TX, OK)	25,927
Plains "Fringe" (MT, WY, CO, NM)	11,410
Total	57,734

Conservation Reserve--1985

The Conservation Reserve Program (CRP) of the Food Security Act of 1985 provides for up to 45 million acres of highly erodable land to be planted to permanent cover. Other papers in this proceedings will discuss the CRP in detail. It is important to note that this program is very expensive (average cost of a Conservation Reserve contract will be $450-500 per acre as compared to the $86 paid during the Soil Bank program). In the western Great Plains this is many times what the land could be purchased for at the present time.

Will the current CRP succeed where the Soil Bank failed and result in permanent retirement of these erodable lands? The Sodbuster and Compliance provisions of the 1985 FSA should help accomplish this. The main question is whether USDA policy and Congressional legislation will remain resolute in preventing re-plowing of these lands when CRP ends. Past history does not provide much encouragement that such resolve will prevail. We seem to be very willing to modify our conservation laws and policies to take advantage of short-term economic opportunities.

One indication of conflicting and potentially harmful policies is the publication of a study by the USDA Economic Research Service on the amount of land not currently cropped that could be converted to crop use (Hexem and Krupa 1987). They reported that about 35 million acres in the United States have a high potential for conversion to crop use and 117 million more acres have medium potential for conversion over the next 10-15 years. They identified 57.7 million acres of range and pasture land in the Great Plains states with a medium or high potential for conversion to cropland (table 4). Although the range and pasture land was not identified by land class, from other figures presented it can be concluded that much of the land identified for possible conversion is in land capability classes IV through VIII.

It appears that some serious policy conflicts are occurring and will continue in the future. Identifying more than 57 million acres of range and pasture land in the Great Plains as having potential to be plowed in the next 10-15 years at the same time that 45 million acres are being taken out of crop production in the Conservation Reserve Program in the entire U.S. does not bode well for a future consistent policy either by USDA or Congress. Plowing new land at the same time or following retirement of substantial amounts of erodable land would negate the effects of a very expensive conservation program.

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Rationale and Legislation for the Creation of the Conservation Reserve Program

E. Wayne Chapman[1]

Abstract.--America's farmers and ranchers provide basic and necessary products fo life on this hungry planet. However, in the 1980s the family farm is caught in the tightening jaws of increasing costs and decreasing prices to the extent that soil conservation practices have often become economically infeasible. The Conservation Reserve Program (CRP), contained in the 1985 Food Security Act, provides the necessary incentives to take highly erodible and eroding land out of crop production, and place it under permanent cover. The CRP, as passed, represented compromises between the Congress and various interest groups.

I love to travel this great land of ours, especially here in the West. I envy you who live out here. I was reminded of what I am missing last month as my wife and I drove through Wyoming and Montana and counted more antelope than cars for several hundred miles.

Shag and Billy are two cowboys that Stan Lynde from Red Lodge, Montana have created and used in his cowboy cartoon book, Grass Roots. Stan was gracious enough to give me permission to use some of his cartoons to help illustrate my talk. I bought Stan's book in Billings, Montana last month while attending the National Soil Conservation Society of America Convention.

I asked Stan if his book was available here in Denver and he said he didn't think so, but added that he would be glad to send you an autographed copy if you wanted to order one from his Red Lodge, Montana address.

In one cartoon, Shag says, "It's not the things I don't know that worry me..It's findin' out I've been wrong about all them things I thought I knew."

There is a lot I don't know about the events that led up to the Food Security Act (FSA) of 1985 and I am sure some of the things I think I know may not be the fact but I am glad to share what I think I know.

Stan not only tells a good story with his pictures but I like the story he paints with the short commentary he includes with each.

For example, in a range cook wagon scene with Billy saying, "It sure is a crazy world, Shag, when almost a third of its people are starving!," Shag replies, "Yep..an' when the world's best farmers a' ranchers can't even make a living!"

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For this picture Stan says, "The way of the world is filled with irony, and it doesn't take a great thinker to see that a lot of life just doesn't make much sense."

By all that's fair and just, America's farmers and ranchers should be among the world's most highly paid and respected people. Their products are basic and necessary for life on this hungry planet and their industry and dedication have led to ever-increasing production on ever-decreasing acreage, and against the perils of predators, weather, crop disease, insects, imports, inflation, and bureaucrats.

Film stars and football players are better paid and honored by far, but you can't eat a movie--and astroturf makes a poor salad.

One cartoon depicts a bear along with Billy and Shag on horses. Billy says, "Holy smoke, Shag! That's a grizzly bear!" Shag replies, "Yep..He belongs to one O' them endangered species..like the family farm." Stan says for this drawing, "Nature's ecosystems are in a state of delicate balance that man, with his arrogance and technology, can easily damage and destroy. But endangered species are not limited to the passenger pigeon, trumpeter swan, and grizzly bear; even institutions can quality."

To Shag, the family farm is such an endangered species, and threats to its existence may include inflation, bureaucracy, land developers, and foreign imports.

Today I plan to discuss why I believe such a strong Conservation Provision was included in the 1985 FSA that authorized the Conservation Reserve Program (CRP). What were the factors that came together to cause this to happen even with such a national debt facing our Nation and a farm economy on the ropes?

Then I will explain a little about what I saw happening from my position on the House Agricultural Committee staff in 1985 while the Bill was developing. Finally, we will examine how the

CRP fits in with the Sodbuster, Conservation Compliance, and Swampbuster parts of the Bill, and what, in addition to putting the highly erodible land in the CRP, farmers will need to do to stay eligible for Farm Program benefits.

The short version of my talk can be summed up in a few words. Congress passed a strong conservation provision in the 1985 FSA because they perceived soil erosion was a serious national menace and they wanted to help farmers do something about it.

They recognized that we have a situation, not necessarily the fault of the farmers, where farmers are hurting and our soil and water, our basic natural resources are hurting. They believed that the CRP would help meet the need of both the farmers and the soil and water resources.

On February 6, 1985, I was just getting into my assignment with the staff of the House Agriculture Committee. I clipped a picture from the USA Today newspaper that showed farm foreclosures had increased by 68 percent from 1982 to 1984, from 844 to 1,422, and as you know the picture hasn't gotten a lot better since.

Back to Stan Lynde's book, <u>Grass Roots</u>. Shag is at a bank; the banker says, "Well..yes, Shag..the bank might consider granting you a loan. What do you want the money for?" Shag says, "I'd like T' buy me some postage stamps, Bob.")

The first six months of 1985 Agriculture committees of both the House and Senate was dominated by farm credit concerns. It was really heart rendering to hear the farm families who were testifying at the hearings tell how they were losing the farm which had been in their family for generations. Even the movie industry was recognizing the widespread hardship in the agricultural sector. Three separate movies were showing during 1985 on the subject and the stars of these movies - Jane Fonda, Jessica Lange, and Sissy Spacek all appeared before the Agricultural committees on behalf of the farmers. Needless to say the hearing rooms were packed when they showed up and several more TV crews were on hand.

One of the things I remember from a political science course was that it usually takes five or more years from the time the need for a law is recognized until it becomes a law. This was true for The Soil Conservation and Domestic Allotment Act of 1935, Public Law 74-46, which is the same basic law the Soil Conservation Service operates under today. The law has never been amended. Let's look back to what was happening prior to its passage, our Nation's first real crack at tackling the soil erosion problem.

In 1928, a young soil scientist, Hugh Hammond Bennett of North Carolina, persuaded USDA to publish Circular 33, Soil Erosion, A National Menace. Congressman James P. Buchanan of Texas held hearings on the erosion menace, and, as a result, in 1930, the first federal money to begin a national survey of soil erosion damage was made available. It was $160,000, to be used by USDA to investigate "the causes of soil erosion and the possibility of increasing the absorption of rainfall by the soil in the United States" (Sampson, 1981).

The person who wrote this statement of purpose was pretty perceptive. He or she recognized that the way to stop soil erosion is to increase the absorption of rainfall by the soil. What happens when just about any conservation practice is applied? The grass and trees we plant on CRP land increase absorption. Conservation tillage, contour farming, and terraces all increase absorption.

The erosion survey confirmed there was a real erosion problem. In 1933, five years after the study was initiated, the Soil Erosion Service was established. Two years later, with a little help from a good dust storm, that may have started just east of Denver, the Soil Conservation Service was established along with a national policy on soil erosion. The policy, as stated in Public Law 74-46, was "... to provide permanently for the control and prevention of soil erosion, and thereby, to preserve natural resources, control floods, prevent impairment of reservoirs, and maintain the navigability of rivers and harbors, protect public health and public lands, and relieve unemployment..." (Burns, 1985).

Why, after more than 50 years with a law that says it is our policy to control and prevent erosion and with the billions of dollars poured into soil and water conservation programs, haven't we solved the erosion problem?

There is a funny thing about nature; it is not the least bit impressed by man's policies and laws. The simple law of nature is that as long as we plow and plant, soil will erode on the steep slopes every time it rains unless it is protected by a good conservation cover. On the steeper slopes, cover alone is not adequate and the slopes must be broken by terraces, strip crops or some other means. It doesn't matter that we solved the erosion problem on the field 30 years ago, 20 or 10 years ago or even just last year. If a new operator takes over or the same operator fails to continue the conservation system, when it rains or the wind blows the soil will erode again.

However, I would like to tell you a personal story that I think illustrates that erosion can be controlled over a long period of time. Last year in August, during the second CRP signup, Don Gillaspie, State Resource Conservationist for the SCS here in Denver, invited me to come out to see first-hand how the CRP was being implemented. My wife and I used that occasion to drive through Vernon, Follett, and Spearman, Texas where we had worked with the SCS. It had been 27 years since we had been to Follett, a town of about 500 people in the very northeast corner of the Texas panhandle. On the way to Follett we drove by Harold Schoenhal's farm. In 1957, Harold was just taking over the operation of the farm from his dad. The previous year, a new law had established the Great Plains Conservation Program (GPCP). I helped Harold write a conservation plan which he used to apply for one of the first Great Plains Conservation Program contracts in the Nation. We started to implement the plan when in 1959 I was transferred, so I hadn't gotten to see the plan fully implemented. As we drove by the farm I was surprised that I remembered the details of Harold's conservation plan as if it had been yesterday. Thirty years ago There was a tremendous erosion problem on the farm.

We planned to plant grass on some of the steep land that sloped into a pasture that had a large draw in it. We planned terraces on the sloping cropland and agreed on contour farming and improved residue and range management to increase cover on the land and increase absorption. We even planned to plant red cedar, Russian olive and other shrubs for wildlife habitat at several spots near windmills.

Harold's name was still on the mailbox and, yes, the terraces and the grass on the slopes were still there. The red cedars, now 30 years old, looked real good. He is continuing to carry out his plan. That made me feel good.

I thought how lucky I am to have been a part of helping influence farmers and ranchers like Harold to conserve their land. I believe the answer to long term erosion control in this country is to convert the owners and operators of the land into practicing conservationists like Harold Schoenhals.

Unfortunately, many farmers have not been practicing good conservation. There are a lot of reasons and excuses given for not doing so. To me the reason is they have not yet adopted a conservation ethic.

Perhaps the most accepted excuse for the excess erosion today is that, when prices of farm products shot up in the 1970's, farmers responded by plowing "fence row to fence row" and plowed out land they should not have. We often like to blame then Secretary of Agriculture Earl Butz for the great plow out. This plow-out resulted in an increase in harvested cropland from 335 million acres in 1972 to 391 million in 1982, an increase of 56 million acres (Burns 1985). That increase amounted to more than the present 40 to 45 million-acre CRP goal. But farmers didn't need Mr. Butz to tell them to plow out those acres; I suspect they would have done it even if he had told them not to.

The point is, highly erodible land was taken from permanent covers of grass and trees, and planted to soybeans, wheat, and other crops; moreover, much of it isn't being farmed properly to prevent excessive erosion. Then, prices dropped and farmers had no extra money to put into soil and water conservation practices. Farmers were hurting and their land was hurting.

Hence, it may well have been the accelerated erosion spawned by plow-outs during the 1970's which is the real reason for the CRP. Many of us who have spent our careers in soil and water conservation, and who have seen scenes of erosion too often following rain and wind storms, would like to think that we finally convinced enough people that we still have a serious erosion problem and we need to do something about it.

The similarities of events that led up to the passage of the Soil and Water Conservation Act of 1935 and the 1985 Act are striking. Remember, 1930 a national erosion survey was commissioned and five years later the 1935 Soil Conservation Act was passed.

A new national erosion survey, the National Resource Inventory (NRI) was completed in 1980, five years before the 1985 FSA. It was published in March 1981. In 1977, Congress had passed the Soil and Water Resources Conservation Act (RCA). This legislation required USDA to set up a formal process to; (1) appraise on a continuing basis the soil, water, and related resources on nonfederal land, (2) develop programs for furthering conservation, protection, and enhancement of these resources, and (3) annually evaluate program performance.

Neal Sampson, in his book "Farmland or wasteland, a time to choose," (1981) said, "The RCA appraisal paints a stark picture: The soil and water resources of the Nation are being wasted at a rate unparalleled in recent times." He went on to point out, "... the Carter administration established the National Agricultural Lands Study (NALS) in mid-1979 as an 18-month effort to answer several important questions about the nation's farmland supply."

The NALS had also been commissioned by the House of Representatives Subcommittee on Conservation, Credit, and Rural Development. It was directed by two very respected and able men, Norman A. Berg, former Chief of he Soil Conservation Service, and Robert J. Gray, Director of Policy Development for American Farmland Trust (AFT) and former Executive Director of the NALS. The stage was set for credibility and ownership of the findings from the study by the scientific community, the Administration, and Congress. This study, conducted by the AFT, concluded that soil erosion on U.S. cropland could be substantially solved, at a reasonable cost, within the decade.

They made 23 specific recommendations. Recommendation 10 was that the 1985 Farm Bill should contain legislative authority for a long-term conservation reserve. Therefore, the RCA, the NRI, and the NALS helped produce a greatly increased awareness of resource problems.

A conservation coalition of 20 to 25 major conservation organizations was formed and headquartered in Washington, D.C. Robert Gray and Norman Berg are leaders in this somewhat unique coalition. It included organizations such as the National Association of Soil and Water Conservation Districts and the Sierra Club, who just a few years ago talked to each other only in the court room trying to settle law suits over "channelization" issues. During the hearings on the 1985 Farm Bill they spoke as one voice in favor of a strong conservation title in the Bill.

Let me talk a little about my year on Capitol Hill. This assignment, which turned out to be one of the most interesting of my career, began in December 1984. The Soil Conservation Service and other Federal agencies participated in a training program which sends a few of its employees to Capitol Hill for up to one year to gain a better understanding of how the laws we are asked to implement are enacted. The participating agencies continue to pay the employees salary and the legislator gets the services of a technically trained staff assistant in return for furnishing the training and administrative support. The participant interviews with Senators and Congressmen and may serve on personnel or committee staff. I chose to work for the House Agricultural Committee staff.

I guess the thing I learned that was of most interest to me was how the committee and subcommittee system works. In the Senate, the committee is called the Agriculture, Nutrition, and Forestry Committee and is chaired this year by Senator Patrick Leahy of Vermont. In 1985, it was chaired by Senator Jessie Helms of North Carolina. The ranking minority member this year

is Senator Robert Dole of Kansas. In 1985, Senator Edward Zorinsky from Nebraska was the Democratic ranking minority member.

On the House side the committee is called, simply, the Committee on Agriculture and is chaired by Congressman E de la Garza of Texas with Congressman Edward Madigan of Illinois being the ranking minority member. Both of these men were also there in 1985 and I was hired by Congressman Madigan since I worked with the minority members of the staff.

But the real nuts and bolts of legislation are put together, not in the committee, but in the various subcommittees. To influence what the legislation says, the most important people to work with are the subcommittee chairmen and ranking minority members of the subcommittee and the staff people who work for them.

There were about 60 separate farm bills introduced in 1985. I nearly ran myself crazy trying to keep up with these until one of the staff asked me why I was bothering. He told me the only bill that we needed to worry about was the one introduced by Congressman Ed Jones, the chairman of the subcommittee responsible for conservation legislation. He had introduced a bill the previous year which passed the House and reintroduced it again in 1985.

This sets the stage for another factor which I think had a lot of influence on the outcome of the conservation title of the Bill. It has to do with people in the right place at the right time.

In 1982, Peter Myers became the first Chief of the Soil Conservation Service not to have come from the ranks of SCS. He was still Chief of SCS when I began my Legislative Fellow training with the House Agricultural Committee, having selected me for the assignment. As Chief of SCS he was, of course, very interested in the conservation part of the Bill. By then he had traveled all over this land and seen the erosion problems first hand. He also brought a farmer's perspective to the job and noticed those farms where erosion was being controlled.

Another incident I think he remembered concerned the 1983 Payment in Kind (PIK) program. When this program was being planned, he and Bud Rank, then Administrator of the Agricultural Stabilization and Conservation Service (ASCS), had met and decided to try to beef up the conservation requirements of the land that would be diverted under the PIK program. I helped develop the instructions that were sent to the SCS State Conservationists. Basically, they said the SCS State Conservationists would approve the amount of cover that would be acceptable on the diverted land. If the residue from the last crop was not managed so it would be adequate to control erosion, a cover crop should be planted. The farm interest groups affected by this requirement got busy, and working with their Congressmen and Senators, caused the Secretary to relax the treatment requirement.

Midway during 1985, after being elevated to the position of Assistant Secretary for Natural Resources and the Environment, Mr. Myers took these concerns and knowledge with him. He was in a position to speak for the Secretary and influence the Administration of the need for a strong Conservation Title. He and Secretary Block met several times with the committees and supported the CRP.

I found myself being used as a communication link between the House Agriculture Committee and Mr. Myers on issues that would arise on which the committee wanted to know the Administration position. Having worked closely with Mr. Myers in the SCS, I felt at ease in picking up the phone and discussing these issues with him.

The major issues resolved around the amendments that were made to the Jones' Bill on the House side and the elms' Bill on the Senate side. The major amendments are outlined below.

Agriculture Committees

Senate

Agriculture, Nutrition and Forestry

Chairman: Patrick Leahy - VT

Ranking Minority Member - Robert Dole - KS

House

Chairman: E de la Garza - TX

Ranking Minority - Edward R. Madigan - IL

The bill that Congressman Jones introduced did not include what we have come to call the Conservation Compliance or Swampbuster provisions; these were added. There was a long debate over the look back time period for the Sodbuster provision and it was changed from a 10-year period to a 5-year period.

An amendment was added to encourage, where practical, 12.5 percent of the CRP acres be planted to trees.

One day a staff member came to my office and said, "Wayne, I need your help in wording an amendment to keep Christmas trees from being grown on CRP land. My Congressman has a lot of commercial Christmas tree growers and they are on his back to see that they don't have this unfair competition." He showed me his amendment and it said that no trees could be harvested on CRP land for a period of 20 years. Well, this wouldn't work too well in the south where they would be able to start harvesting pulp wood shortly after the 10-year CRP contract expired. So we reworked the amendment to be a little more straightforward and just prohibit the planting and harvesting of Christmas trees. About that time a representative for the National Cattleman's Association found out about the amendment and took the opportunity to convince the Congressman to include a prohibition of haying and grazing. The House version up until now was silent about harvesting the CRP land but the Senate was considering allowing harvesting.

The original House version had no acres mentioned for the CRP. This was one of the amendments I was asked to check with Mr. Myers. De told me the Department would support a 20 million acre program. I relayed this to Susan Atkins, who is

Congressman Tom Coleman's staff person, and she and I developed an amendment which Congressman Coleman introduced to establish the CRP at a 20 million acre level. After the amendment passed, Congressman Edward Madigan added 5 million with a provision that the payments could be made with surplus commodities or payment in kind. The Senate had been considering a 30 million acre program, but at the last minute increased this to 40 to 45 million acres. The Senate version was adopted in conference, which was somewhat of a surprise because they usually just split the difference.

The original House version had no limit on what percentage of cropland acres in a county could be placed in the CRP. An amendment by Congressman Cooper Evans of Iowa added the 25 percent limit. There was quite a controversy about adding an amendment to make other than highly erodible land eligible for the CRP. In the long run, those in favor of keeping erosion control as the main emphasis won. The amendment was worded to allow, but not require, the Secretary to, "... where appropriate, accept contract offers that provide for the establishment of (1) shelterbelts and windbreaks, or (2) permanently vegetated stream borders, filter strips of permanent grass, forbs, shrubs, and trees that will reduce sedimentation substantially.

Now a short discussion on how the CRP fits with the other conservation provisions? Most of you by now are familiar with the three subparts of Title XII of the FSA - Conservation Reserve, Highly Erodible Land, and Wetland Conservation. You know that the Highly Erodible Land section is divided into two parts - Sodbuster and Conservation Compliance.

CRP can be considered the carrot and the other three provisions the stick. We made what I think is a serious error in not developing the rules for all these provisions together. We moved out so fast on the CRP that neither the farmer nor the Soil Conservation Service personnel have had time to develop conservation plans that will meet the Conservation Compliance requirements. Ideally, the conservation plans that are required by 1990 under the Conservation Compliance requirement should be developed, and the CRP and other cost share programs used as tools to help carry out these plans.

For this reason I have been against the bidding feature of the CRP from the start. I would have opted for pools with similar land to have been established as they were for the bidding pools and a rate that was acceptable to the Secretary be established for each pool. Then, as the farmer submitted a conservation plan that met the requirement of the Conservation Compliance section, they could be accepted as a CRP contract for any land they planned to convert to grass, trees or wildlife cover.

This follows the GPCP concept used by Harold Schoenhals which served not only to convert the land to grass but to convert the farmer to a conservation farmer.

Our job now is to try to catch up with the conservation planning required by the conservation compliance provision and hope to be able to incorporate the CRP contracts into those plans.

History of Cropland Set Aside Programs in the Great Plains

Earle J. Bedenbaugh[1]

When you examine historical accounts of agricultural policy the task can become monotonous, nonetheless, such reviews are often useful when trying to see into the future. When I look back over the past 60 years of farm programs, I come to the conclusion that, through these years, we have made short-term solutions to long-term problems. And, as this history unfolds, I think you probably will come to the same conclusion.

From the beginning of the 1930's, federal cropland programs have sought to adjust the production of certain commodities, in effect, to support the prices and incomes received by farmers. These programs over the years have included minimum conservation requirements on qualified acreage. Conservation was a secondary purpose even though conservation benefits at times have been quite significant. However, these programs were first and foremost aimed at price enhancement through supply control, and it was on that basis that their performance was usually evaluated.

For most of this century, the central problem in American agriculture has been one of overproduction, and we certainly have that problem today. Continual advancement from technology and cultural practices generally have kept production ahead of demand except during war time periods and a few short-term periods that we called the golden age of agriculture. These periods occurred between 1900 and 1914, and, more recently, we have seen evidence of this golden era of agriculture during the 1970's.

It was in the 1920's that the commodity supply problem first became critical enough bring about serious and widespread proposals for government intervention in the market place. A number of plans were proposed, but the legislation that was enacted, the Agricultural Marketing Act of 1929, soon proved unworkable. It attempted to bolster prices through purchases in storage loans to farm cooperatives; however, surpluses continued to glut the market and to depress prices. Short-term solutions to long-term problems.

The economic depression that would paralyze the rest of the nation in the 1930's struck first in agriculture when sharp price decreases and drops in exports left overextended farmers with heavy debts, reduced acreages, and low income. This certainly sounds like today, doesn't it?

By 1933 the crisis had deepened, and farmers were increasingly desperate. Export markets had virtually dried-up, the already low farm prices tumbled to levels not seen before in this century, and foreclosures and forced auctions had swept through the farmbelt. Even the Farm Bureau warned of revolution in the countryside if something was not done to help American farmers. The government responded to this emergency with the Agricultural Adjustment Act (AAA) of 1933 which for the first time authorized production controls as a primary means of raising farm prices and farm income. The AAA provided a number of tools to deal with the farm crisis, including acreage control, margin agreements, direct payments to farmers, nonrecourse law, and authority to tax and license processes. They charged a new agency, the Agricultural Adjustment Administration, with the task of developing and operating specific commodity programs with the assistance of producer committees.

Wheat, cotton, corn, hogs, rice, tobacco, and milk were covered by the original legislation, and more commodities were added later. It can be safely said that the Secretary of Agriculture received more discretionary authority under the AAA to make and change farm policy than in any subsequent farm bill. The Act was a voluntary production control contract in which individual farmers agreed to reduce their acreage in return for direct payments financed by a tax on processes. These were voluntary programs. As an additional emergency measure, cotton and tobacco farmers plowed up portions of their growing crops in 1933 in return for rental payments. The first programs for these crops were voluntary; however, at the urging of producers and the producer committees that were in place at that time, cotton and tobacco became compulsory programs. Heavy taxes were levied on noncompliers using acreage controls approved in a referendum of producers. Again short-term solutions to long-term problems.

The Great Plains economic depression was magnified during the 1930's by devastating droughts and dust storms. The old farm-out-and-move-on philosophy that had lingered throughout the region bore bitter fruits in the dustbowl days of the plains. According to an old AAA pamphlet, Great Plains farmers were among the longest and strongest supporters of the AAA in the

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early days. In 1934, 88% of North Dakota farmers and 80% of South Dakota farmers participated in the Program, leading all other states. Participation was also high in Nebraska, Texas, and Oklahoma. With strong support from farmers and farm organizations, AAA programs did work to significantly reduce acreage, although drought also figured considerably in the production decreases.

Prices for commodities rose markedly after passage of the AAA. Farm incomes rose 50% from 1932 to 1935, primarily due to direct payment from the government. However, in 1936 the Supreme Court invalidated the production control contracts and processing tax features of the law, and the adjustment program came to an abrupt halt. Fearing the prospect for renewed overplanting and depressed prices, USDA and farm leaders urged Congress to swiftly pass new legislation before spring planting. Enacted one month after the Supreme Court decision, and I wish we could get legislative positions to come into place as quickly now, the Soil Conservation and Domestic Allotment Act made soil conservation the rationale for acreage cuts. The Soil Conservation Service (SCS) was founded in 1936, and helped start a conservation effort that we have been going through for the last 50 years.

Farmers received payments for voluntarily shifting from crops to soil conserving grasses and legumes on their lands. They were also paid for adopting soil building practices. Unfortunately, severe drought temporarily masked the programs inadequacy for controlling production, but when surpluses grew and prices toppled in 1937 there was no doubt that more action was needed to divert renewed production. Again we see short-term solutions for long-term problems.

In 1938 Congress passed a second Agricultural Adjustment Act which, with many amendments and modifications over the years, has remained on the books as our Nation's fundamental farm support law until this date. It retained the voluntary allotment conservation payment provision of the 1936 law, but added mandatory controls in the form of marketing quotas for wheat, corn, cotton, tobacco, and rice. When supplies were expected to exceed certain levels, marketing quotas had to be proclaimed; however, the quota in practice did not limit the quantity farmers could produce or market, but rather the acreage needed to produce those quotas. If farmers approved the quotas by a two-thirds majority, allotments become mandatory and farmers were limited to planting a specific percentage of their historical acreage. Noncompliers paid a very heavy penalty.

This system of limiting acreage rather than quantity was more acceptable to farmers since it allowed them to raise as much as they could on their reduced acreage. However, while the quotas and allotments that were put into effect under law generally succeeded in reducing acreage, production did not fall proportionately. Farmers participated heavily, but yields rose through more intensive farming practices and, in the case of corn, the use of hybrid seed. Thus, as a means of supply control, it allowed considerable slippage.

World War II brought a temporary end to mandatory controls as farmers were urged to increase production for the war effort. The large stocks that had accumulated in graineries become a military reserve of crucial importance to the United States and our allies. To ensure plentiful production, the government offered guarantees of high fixed price support in contrast to the lower adjustable loan rates of the 1930's. New commodities were continually added to the support list for the war effort. By the end of World War II, more than 100 commodities were being supported. The basic program structure set by the 1938 Act remained in place, but was adapted to promote production for war crops. For instance, farmers in states with minimum acreage requirements for soil conserving crops were notified that soybeans would be classified as an erosion resisting crop for payment purposes.

High demand during the Korean war offered a temporary reprieve from problems of surpluses; however, by 1954 mounting surpluses led to the legal requirements for marketing quotas once again.

The Eisenhower Administration philosophically opposed mandatory controls, preferring a more market-oriented policy toward flexible and lower price supports. These proposals ran aground in Congress, and compromise legislation that passed in 1954 proved ineffective primarily because of rapidly increasing productivity. Productivity grew at a faster pace during the 1950's than in any previous decade of the century. Encouraged by high war time prices and price guarantees, farmers were making heavier use of fertilizers and pesticides, and were rapidly adopting a host of new high yielding crop varieties, better breeds of livestock, and labor saving machinery. However, the control programs, themselves, had their usual effects on intensifying production on permitted acres.

Another reason the acreage program did not work well in the 1950's was that they were no longer applied as strictly as they had been in the past. For example, the use of land removed from production of allotment quota crops had changed substantially. In the late 1930's this land had to be planted in soil- conserving crops, generally grasses and legumes. But the definition of soil-conserving changed during the war years so, when the controls were imposed in the 1950's, reduced acreage could be planted with almost anything except for marketing quota crops. This situation became known in the USDA as "shifting of surpluses." Diverted acres were planted in crops that soon themselves were over- produced. Much of the land taken out of corn, for example, went into soybeans, rye, flax seed, and hay. Again short-term solutions to long-term problems.

In 1956 the stage was set for a new acreage control program that sought to retrieve more of the land than could be reached under the allotment system. It was called the Soil Bank. The Soil Bank became the largest land retirement program enacted since the 1930's. Farmers at that time were often accused of being wards of the government. As one witticism went, "A farmer put his land in the soil bank, his rear end on the river bank, and his money in the national bank." We in agriculture have obviously lived with that image ever since.

The Soil Bank had two parts. Acreage reserve was a short-term acreage reduction for wheat, corn, cotton, rice, tobacco, and

peanuts. Farmers received payments for converting land to conserving use. The long-term Conservation Reserve was open to all farmers, and retired land under three to ten-year contracts in return for cash rentals. Conservation cost-sharing payments were made for maintaining permanent cover on these idle acres. Soil Bank had ambitious goals but neither of the two reserves were very successful in slowing production. In its peak year the acreage reserve idled 21.4 million acres, but it was so costly that Congress ended the program in 1958. Another short-term solution of a very long-range problem.

By 1960 the Soil Bank Conservation Reserve signed up 27.7 million acres or about 6% of the total U.S. cropland. This included 15 million acres formerly planted to wheat and feed grains. To curb intensive farming on land outside the Soil Bank, the government encouraged the removal of whole farms; thus 70% of the crop land in conservation reserve was taken out in whole farm units. The program had no erodibility criteria for entry, but it nevertheless retired largely marginal land. Consequently, it had little appreciable effect on production and surpluses. Its conservation benefits were substantial in areas where participation was the highest, however.

The Soil Bank returned grasses to vast areas of the Great Plains that had been planted in grain during the war years. In the Southeast 2 million acres of trees were planted, thereby encouraging a growing forest industry in that region. More than 300,000 ac. were devoted to wildlife habitat. However, wide spread opposition to the program by local businessmen and farm suppliers led to the end of the Soil Bank days. The Administration was unable to renew that Soil Bank in 1960, although the last land under contract did not leave the program until the early 1970's.

By 1960 the stock levels of corn and wheat set record highs and prices of these crops were at the lowest levels since the 1940's. The Kennedy Administration was, nonetheless, convinced that mandatory controls could work to manage supply if the mechanism was switched from acreage control to true quotas on the amounts that could be marketed. Under the proposed plan, farmers of any crop would be able to vote on whether to implement marketing quotas that offered a high price support or to return to acreage cuts. Minimal national acreage allotments would be abolished. Congress rejected this extensive system of mandatory controls, but it did approve a referendum on the plan for wheat producers in 1963. However, wheat producers decisively turned down the proposal after a heated campaign.

Legislation that followed the wheat producers referendum set the pattern for future programs in that voluntary rather than mandatory controls were used to adjust production for most crops. Mandatory controls on corn had ended in 1950, preceding the rejection of quotas by wheat producers in 1963. Programs for these crop years emphasized voluntary acreage reduction as a contingent for price support. However, farmers could receive payments in cash or in kind if they diverted additional acres to conserving uses. These voluntary programs successfully retired large acreages through the decade but at considerable cost. Optional paid diversions and supplemental price support programs pushed payments to farmers up from 1.7 billion dollars in 1960 to 3.7 billion dollars in 1970. On the other hand, surpluses were basically under control despite yield increases, mostly as a result of rising exports during the 1960's which helped to absorb these production increases.

A major change in world markets in the early 1970's, caused by unprecedented Soviet grain purchases and world crop shortages, resulted in sharp increases in U.S. exports. Market prices moved well ahead of support levels and government stocks were liquidated.

As concern shifted from crop surpluses to world food shortages, Secretary Butz emphasized increasing rather than decreasing production, and freed farmers from planting restrictions for the first time in 30 years. Most set aside lands in the early 1970's gave way to none at all for wheat and seed grains from 1974 to 1977, cotton from 1973 to 1981, and for rice from 1976 to 1982. Spurred by higher prices, farmers added 20 million acres to cropland before the decade had ended. Unfortunately, the fence-row-to-fence-row planting spree included plowing millions of acres of fragile rangeland and other highly erodible land. Many wetland areas were drained and converted to marginal cropland.

The impact of commodity programs on resource conservation became a stronger issue in the following years. Policymakers became concerned that millions of cropland acres were eroding above the soil loss tolerance. In the 1980's, as we know, the economic climate changed dramatically. A number of factors, including worldwide recession, a strong dollar, rigid price supports, and record foreign and domestic production, combined to sharply reduce both U.S. export levels and crop prices. Secretary Block tried a small acreage diversion program in 1982, but it was not effective because of good weather and high yields. By 1983 government-held stocks, grain, and cotton were approaching and surpassing records set in the late 1950's. Again, a series of decisions that represented short-time solutions to long-term problems.

In that year the Administration launched a Payment-In-Kind (PIK) Program, the largest acreage diversion program in history. Under PIK farmers could choose to idle from 10-30% of their basis on top of the unpaid diversion in return for deliveries of the same commodities. Participation was extremely high, and an unprecedented 78 million acres were diverted to conserving uses.

Together with a drought, the Program reduced total production of PIK commodities by about 35%. Surplus stocks of feed grains, rice, and cotton fell substantially. PIK also resulted in a reduction of average erosion by 1.4 tons per acre for the lands in the Program, according to a recent study. Since 1984, however, surpluses have continued to grow despite large acreage reductions and paid diversions. About 43 million acres were idle in 1986, and the Program will idle approximately 54 million acres in 1987. If we add this figure to the nearly 23 million acres enrolled in conservation reserve programs, the total is close to that idled during the 1983 PIK program. Nonetheless, commodity prices still go down, exports go down, and again a short-term solution to a long-term problem.

The Food Security Act (FSA) of 1985 added some important provisions to reduce adverse impact of commodity program

incentives on use of marginal land. These provisions known as Sod Buster, Swamp Buster, and Conservation Compliance, deny federal farm program benefits to farmers who produce crops on highly erodible lands or who drain wetlands for crop production without an approved conservation plan. Conservation has been used as rationale for production adjustment in past years, but this is the first time eligibility for farm program benefits have been made contingent upon proper soil stewardship.

The new Conservation Reserve Program (CRP) of the FSA is intended to bring more consistency to commodities and conservation program objectives. Unlike the old Soil Bank Program, the CRP specifically targets the idling of highly erodible land. Given our continued problem of surpluses, it makes no sense to encourage unneeded production on land where erosion is already a problem. However, CRP is not viewed as primarily a reduction adjustment program with secondary conservation benefits. It is a conservation program that will have a desired impact on reducing surplus production as more land is enrolled. Unfortunately, as we view 50 years of experience with acreage control, we can see that success in limiting overall production by this means has been limited at best, primarily because farmers have always farmed permitted acres more intensively when a controlled program is in place. But, mandatory or voluntary, these programs still serve as a mechanism to slow increases in crop production.

Acreage control has been seen as a necessary part of price support programs by every administration that has had to face the problem of overproduction. The Reagan Administration is no exception. The solution we have proposed involves gradual phase-outs of both price and income supports and, along with that, a need for acreage control programs. So far, this has been rejected by Congress. We believe there is considerable recognition of the need for a serious forum of our price support and production adjustment machinery. Until this is achieved, however, we will continue, as our predecessors did, to use the tools at our disposal.

It is estimated that this year we will see again dramatic changes in farm legislation and amendments to the 1985 Food Security Act. I think at some point in time we are going to have to take a basic sound philosophy concerning agricultural legislation, put it into effect, and see it to its ultimate end. It is very difficult to see things to an end sometimes.

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Climate and Weather of the Great Plains

Gene C. Wilken[1]

Abstract.--Great ranges of temperature and precipitation are products of atmospheric controls, especially continentality and air masses. Average conditions establish the general climate, but extreme events also are "normal." Strategies to deal with such uncertainties should incorporate data on average and extreme conditions, relationships between climate, crops, and economic activities, and experiences from analogous regions.

Perhaps the two most distinctive features of Great Plains climate and weather are range and variability. These two characteristics introduce high levels of risk and uncertainty to many economic and social activities in the region. Since the weather itself cannot be controlled, decisionmakers and planners must develop strategies based on an understanding of the climate, and flexible responses to its uncertainties.[2]

Two aspects are important; (1) the average conditions, including normal variations, that set the general context for biological and economic activities, and (2) the likelihood that the actual weather at any particular time or place will deviate from the norm. Both the average conditions and the deviations are important for those who make decisions and plan. This paper will briefly consider some basic features of Great Plains climate, especially those that contribute to its range and variability, types of information that are readily available, and strategies for coping with Great Plains weather and climate.

Characteristics of Great Plains Climate

Winters in the northern Great Plains are the coldest in the contiguous 48 states. Often, the plains are cold all over (fig. 1)! In January parts of Texas and Oklahoma can be as cold as Michigan and Ohio, far to the north (Rosenberg 1987). In the summer the Great Plains can be as hot as parts of the tropics (fig. 2). Fall and spring, during which the region makes the shift from northern cold to tropical hot, are transition periods of great change in temperature and precipitation.

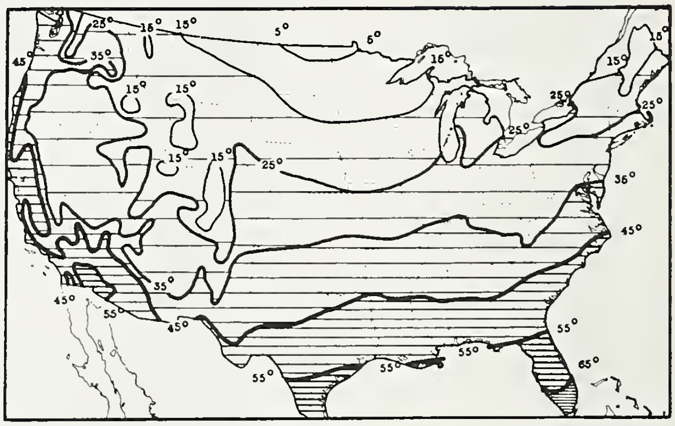

Figure 1.--Normal winter temperature (Visher 1954:24).

To understand these ranges and variations we must look at the physical region and its major atmospheric controls. Much of the climate of the Great Plains is explained by three of these controls: continentally, air masses, and mountain barriers.

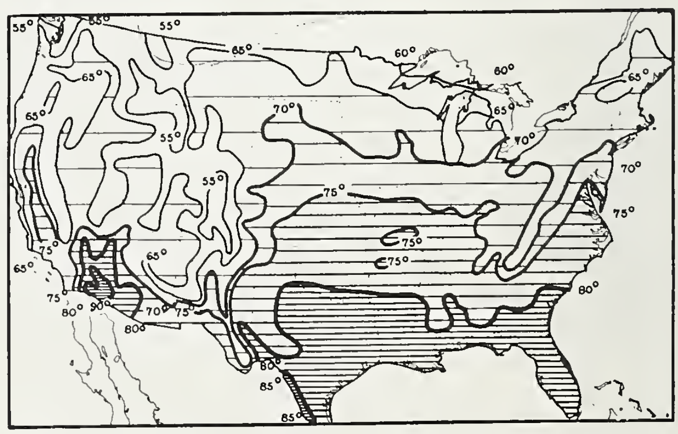

Figure 2.--Normal summer temperature (Visher 1954:24).

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[2]*As used here, weather is what is experienced at any particular time: hot or cold, wet or dry, windy or calm. Climate is a statistical description of what should occur on the average. Seldom if ever does a completely average season or year occur since most of the time the temperature, precipitation and other weather elements are either above or below average.*

Continentally refers to the great temperature ranges associated with major land masses. Large water bodies such as seas or oceans heat and cool slowly and maintain relatively uniform temperatures throughout the year. The resulting moderate or maritime temperature regime may be transferred to adjacent land areas by wind systems. On the other hand, land surfaces heat and cool quickly both diurnally and annually. The Great Plains, located deep within the North American land mass and far from the moderating influence of major water bodies, have a continental temperature regime of great annual range.

Air masses, the second control, are large bodies of lower atmosphere, on the order of hundreds of square miles in size, that have fairly uniform characteristics of temperature and humidity that they take from the surfaces over which they form. The temperatures from warm southern or cold northern land masses, or from moderate ocean surfaces are imparted to the air masses above them by radiation and turbulent mixing. In addition, more water generally evaporates from ocean surfaces than from land areas. Combinations of these temperature and moisture conditions identify four major air mass types:

Type	Symbol	Characteristics
Continental tropical	(cT)	warm-dry
Continental polar	(cP)	cold-dry
Marine tropical	(mT)	warm-wet
Marine polar	(mP)	cold-relatively wet

Once air masses have taken on the characteristics of the underlying surfaces they may move out of their source areas and transfer these characteristics to other regions. Common source areas for air masses that invade the Great Plains are:

Air mass	Source area
cT	U.S. southwest
cP	Canada and the northern states
mt	Gulf of Mexico
mP	Northern Pacific/Gulf of Alaska

Air mass movements are also influenced by mountain barriers. The mountain ranges of the western United States trend mostly north-south, or perpendicular to the westerly winds that prevail at these latitudes. The mountains partially block invasions of mp air masses from the west and contribute to the generally semi-arid conditions, especially in the western Great Plains (fig. 3).

On the other hand, the region is open to invasions of mT (Gulf), cP (Canadian) and cT (Southwest) air masses that originate to the north and south. The result is that the Great Plains are a battle ground of air masses: Bitterly cold air out of the north in the winter; warm wet air from the Gulf of Mexico in the spring (which brings much of the annual precipitation), and occasionally hot dry air from the Southwest during summer.

Unsettled weather and precipitation often occur along the plane of contact, or front, between air masses of different characteristics. The Great Plains are also the windiest part of the United States as a result of the frequent air mass exchanges and flat nature of the region.

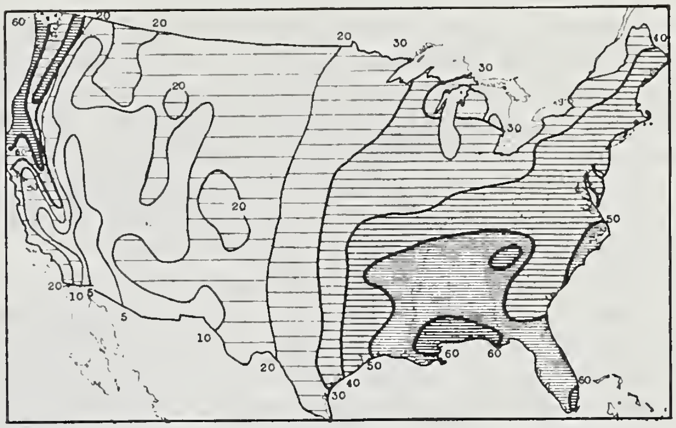

Figure 3. Normal annual precipitation, in inches (Visher 1954:197).

Superimposed on the average march of seasons are longer-term variations: clusters of wet or dry, or hot or cold years that may persist for a decade. But these should not be considered aberrations since "normal" conditions are only statistical averages of actual weather that usually range above and below the mean. Short- and long-term deviations from the mean are also normal parts of Great Plains weather.[3]

In extreme cases variability goes beyond the normal range and constitutes a climatic hazard, the most familiar of which is drought but can also be exceptionally hot or cold temperatures, high winds, early or late frosts, violent thunderstorms and hail, and tornadoes. One hazard can be threatening enough; if two or more hazards occur together, such as drought and high winds, the results can be catastrophic. But even these extreme events, or hazards, are part of the Great Plains environment, to be expected from time to time (Warrick 1980).

Information

The constantly changing climate poses a continuing challenge to life on the Great Plains. Since little can be done about the weather itself, the solutions are primarily managerial; i.e., knowing about average conditions, and probabilities of extreme events, and being flexible enough to work with, not against, these difficult conditions.

Data on the climate, especially temperature and precipitation, but also such elements as wind, evaporation, cloudiness, and solar radiation, are abundant. Medium- to long-term records exist for dozens of stations in the Great Plains. Averages have been calculated and extremes recorded, in some cases for more than 50 years. General climatic features of most locations are

[3]Evidence from tree ring analyses and historical materials suggest that parts of the Great Plains have experienced droughts in the past more severe than any that have occurred in recent times. Such long and severe events would impact heavily on the modern economy of the region.

well known, as are the probabilities of specific events occurring at any particular time. Thus, the statistical probability of frost at any particular date and length of frost-free season are known for most of the major weather stations. In addition, published materials contain such things as number of clear days during the year, zones and speeds of high winds, number of hailstorms for a particular area, sequences of wet or dry days, and drought extent and severity (Benci and McKee 1977; Berry 1968).

Besides climatic data, there are studies of interactions or relationships between biological and social activities and weather elements. The most familiar of these are crop-climate relationships; e.g., heat and water requirements of common crops. Correlations in the public utility area, such as heating fuel consumption in relation to degree days, and water consumption at various levels of temperature and precipitation also are common. In addition, studies of cattle weight gain, public transportation use, shopping behavior, health, and even crime in relation to various weather elements are available.

Combining data on climate averages, normal ranges, and probabilities of extreme events with the various biological and social responses can reduce the uncertainty and risk of dealing with Great Plains weather. With available data, contingency plans can be developed for almost any condition, even in the climatically variable Great Plains.

Strategies

Dealing with the Great Plains environment requires a high degree of flexibility. In farm and ranch operations flexibility is achieved through alternative crops and timing of field operations, and actual climate-modifying techniques such as irrigation, windbreaks, and shading. Flexibility is also provided by equipment and staffing levels. For example, a large proportion of capital equipment that distinguishes United States agricultural enterprises from those in other parts of the world allows Great Plains farmers to take advantage of short spells of favorable weather to plant and harvest.

Another basic strategy for dealing with the environment involves anticipation or prediction. To be useful, reliable estimates on what will occur should be available far enough in advance so that defensive measures can be taken. Because of the magnitude of forces involved and the enormous number of variables, the task is extraordinarily difficult. Nevertheless, satellites and computers are providing more and better short-term and intermediate forecasts and eventually long-range forecasts of sufficient accuracy to use in planning may be possible.

Finally, identifying strategies from other regions would be useful. Similar environments, or agroclimatic analogues, occur elsewhere in the world. For example, the Ukraine of the Soviet Union is reasonably close climatically to the Great Plains (Granovskaya 1968; Nuttonson 1965), and there are other areas in Africa, Asia, and South America that are comparable. However, different histories and customs in these analogous regions have produced different management techniques. It would be of considerable interest to know how people and institutions in other parts of the world respond to the normal and unusual conditions that occur in these similar environments.

Could the methods used in other regions really be useful here? Although social and technical differences are often great, the analogous regions share the great ranges and variations of temperature and precipitation, and high levels of risk and uncertainty found in the Great Plains. Comparable challenges call forth comparable responses. The experience of others might well offer new alternatives for planning and management in this difficult environment.

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Historical Development of Native Vegetation on the Great Plains

James Stubbendieck[1]

Abstract.--Original vegetation of the Great Plains was primarily grassland. Over 20 types of natural vegetation are placed into six categories and the dominant species are listed. The environmental factors and historical events influencing evolution of grasses, grasslands, and herbivores are discussed.

One of the largest real estate purchases in the world was made in 1803 when the Government of the United States, under the direction of President Thomas Jefferson, purchased over 500 million acres from France for $15 million. This purchase included most of the Great Plains depicted in figure 1. Little was known about the resources, including the vegetation, at the time of the purchase. Only a few trappers and explorers had extensively traveled in the area. Unfortunately, some early organized explorations coincided with periods of drought. Much of the Great Plains was condemned as the "Great American Desert." This title presented a particularly stubborn obstacle to settlement (Emmons 1971), and may have only meant that the area was deserted, especially by man (Murray 1897). The area was not a desert. It was covered with vegetation, primarily prairie vegetation (von Humboldt 1896).

Vegetation is a term that is collectively used to describe the plant life of an area. The vegetation of the Great Plains has been variously described as prairie, grassland, and rangeland. Prairie has been defined simply as an extensive tract of level or rolling land that was originally grass-covered and treeless (Range Term Glossary Committee 1974). This land is not necessarily currently covered with prairie vegetation or with vegetation originating in North America. Others have more complex and emotional views of prairies (Rose 1975). Prairie vegetation is predominantly grasses, but forbs, grasslike plants, and woody plants are common (Weaver 1954). Prairies must evolve. They are not planted. On the other hand, the term grassland is used to describe any area on which grasses dominate. These grasses are not necessarily native to those areas. One phase of the Conservation Reserve Program (CRP) is to establish grasslands, not prairies. Another term requiring definition is rangeland. It is dominated by vegetation useful for grazing or browsing (Range Term Glossary Committee 1974). Management is routinely through grazing rather than by renovation and/or cultural treatment.

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One purpose of this paper is to briefly describe the types of natural vegetation found on the Great Plains and the factors affecting vegetation. Evolution of grasses, grasslands, and herbivores will be discussed.

Vegetation of the Great Plains

The grassland biome of the Great Plains is the largest vegetational unit in North America (Gould and Shaw 1983). Decreasing precipitation across the Great Plains from east to west is accompanied by changes in productivity and species composition (Weaver 1954). As a result, three major regions have been distinguished (Oosting 1956). The eastern part, where the precipitation is the highest, is generally called the true prairie or tall grassland. The dominant grasses are usually over 4 ft. in height. The short grassland occurs in the driest regions, and dominant grasses are usually less than 2 ft. The mixed grassland is in the center where grasses are of intermediate and mixed heights.

Diversity of the natural plant communities of the Great Plains is illustrated by the occurrence of over 20 types of natural vegetation (Kuchler 1964). These can be grouped into six broad categories (fig. 2).

Black Hills Forest

Black Hills Pine Forest *(Pinus)*[2] is located in South Dakota and Wyoming. The dominant is tree ponderosa pine *(Pinus ponderosa)*[3]. Grasses such as western wheatgrass *(Agropyron smithii)*, bluebunch wheatgrass *(Agropyron spicatum)*, blue grama *(Bouteloua gracilis)*, and needleandthread *(Stipa comata)*

[2]*Natural vegetation types generally follow Kuchler (1964), but they have been modified and updated to reflect current knowledge and taxonomy.*

[3]*Nomenclature follows Stubbendieck et al. (1986) or the Great Plains Flora Association (1986).*

are common in open areas. Threadleaf sedge *(Carex filifolia)* and other carices add to the grazing resource.

The Eastern Ponderosa Forest *(Pinus)* is located in Montana and is also dominated by ponderosa pine. Western wheatgrass, blue grama, and needleandthread are common in the open forest.

The Northern Floodplain Forest (Populus-Salix-Ulmus) borders the rivers and streams from Oklahoma northward. Only a few understory plants produce adequate quantities of forage for grazing.

Hardwood Savanna

A hardwood savanna occurs along the southeastern edge of the Great Plains. Much of it is not completely forested but is a mosaic of Oak-Hickory Forest *(Quercus-Carya)* and Bluestem Prairie *(Andropogon-Panicum-Sorghastrum)*. Oak-Hickory-Pine Forest *(Quercus-Carya-Pinus)* and Cross Timbers *(Quercus-Schizachyrium)* are represented in the southern portion of the Grassland Forest. Few forage producing plants grow in the Oak-Hickory-Pine Forest. Trees are scattered or in extensive groves in the Cross Timbers. Little bluestem *(Schizachyrium scoparium)* is a dominant. Other important forage species are big bluestem (*Andropogon gerardii* var. *gerardii*), sideoats grama *(Bouteloua curtipendula)*, hairy grama *(Bouteloua hirsuta)*, Canada wildrye *(Elymus canadensis)*, purple lovegrass *(Eragrostis spectabilis)*, sand lovegrass *(Eragrostis trichodes)*, switchgrass *(Panicum virgatum)*, indiangrass *(Sorghastrum nutans)*, tall dropseed *(Sporobolus asper)*, and Texas wintergrass *(Stipa leucotricha)*.

Figure 1.--Location of the Great Plains.

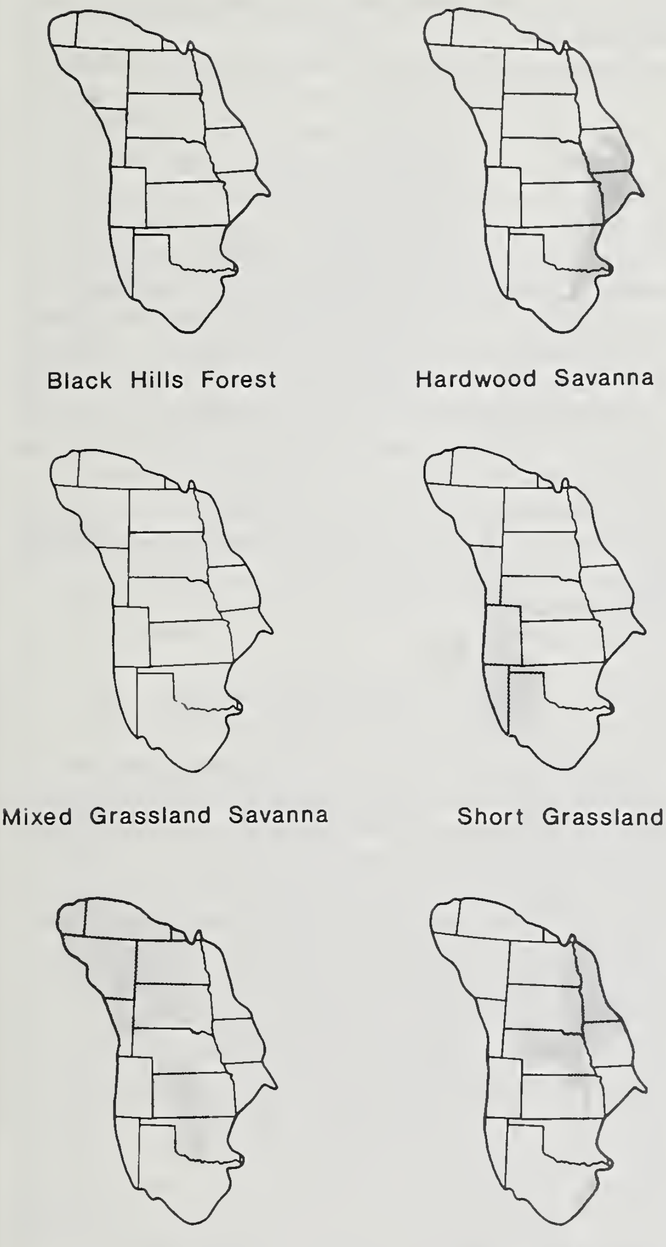

Figure 2.--Types of original vegetation on the Great Plains.

Mixed Grassland Savanna

Mixed Grassland Savanna is found primarily in west-central Texas. It is comprised of Mesquite-Oak Savanna *(Prosopis-Quercus-Schizachyrium)*, Juniper-Oak Savanna *(Juniperus-Quercus-Schizachyrium)*, Mesquite-Buffalograss *(Prosopis-Buchloe)*, and Mesquite Savanna *(Prosopis-Hilaria)*. These types of vegetation have trees in varing densities with understories of grasses. The most abundant and important grasses are little bluestem, buffalograss *(Buchloe dactyloides)*, threeawns (*Aristida* spp.), sideoats grama, hairy grama, silver bluestem *(Bothriochloa saccharoides)*, green sprangletop *(Leptochloa dubia)*, vinemesquite *(Panicum obtusum)*, curly mesquite *(Hilaria belangeri)*, and tobosa *(Hilaria mutica)*.

Short Grassland

The Short Grassland is located on the high plains which extend from the Texas panhandle to southeastern Wyoming. This area lies in the rain shadow of the Rocky Mountains and receives the least amount of precipitation. Over 90% of the area is Grama-Buffalograss *(Bouteloua-Buchloe)*. Dominants are blue grama and buffalograss. Many of the other components are different in the north than in the south. Cool-season species, such as western wheatgrass, are more abundant in the north, while the warm-season grasses sideoats grama and ring muhly *(Muhlenbergia torreyi)* are more abundant in the south. Other important species include red threeawn *(Aristida purpurea)*, hairy grama, western wheatgrass, scarlet gaura *(Gaura coccinea)*, curlycup gumweed *(Grindelia squarrosa)*, ironplant *(Haplopappus spinulosus)*, prickly pears (*Opuntia* spp.), woolly plantain *(Plantago patagonica)*, slimflower scurfpea *(Psoralea tenuiflora)*, upright prairieconeflower *(Ratibida columnaris)*, senecios (*Senecio* spp.), scarlet globemallow *(Sphaeralcea coccinea)*, sand dropseed *(Sporobolus cryptandrus)*, and small soapweed *(Yucca glauca)*.

Mixed Grassland

Mixed Grassland occupies the largest area in the Great Plains. It is located in the northwest and in an area in the south-central Great Plains separated by the Nebraska sandhills. As its name implies, the Mixed Grassland contains short, mid, and tall grasses. But, it also includes many species of forbs. The vegetation in the south-central area is primarily Bluestem-Grama Prairie *(Schizachyrium-Bouteloua)*. Dominants are little bluestem, sideoats grama, and blue grama. Other important components are western wheatgrass, western ragweed *(Ambrosia psilostachya)*, leadplant *(Amorpha canescens)*, big bluestem, buffalograss, Fremont clematis *(Clematis fremontii)*, slender dalea *(Dalea enneandra)*, black samson *(Echinacea angustifolia)*, western wallflower *(Erysimum asperum)*, dotted gayfeather *(Liatris punctata)*, evening primrose *(Oenothera serrulata)*, switchgrass, slimflower scurfpea, indiangrass, and tall dropseed. The majority of this area has been placed into cultivation, but relatively large tracts remain in native vegetation.

A vegetation type occupying a much smaller area is the Sandsage-Bluestem Prairie *(Artemisia-Schizachyrium)*. It is scattered along the western edge of the Mixed Grassland. It contains many species of grasses and a strong element of dwarf shrubs. Dominant plants are little bluestem, sand sagebrush *(Artemisia filifolia)*, hairy grama and sand bluestem (*Andropogon gerardii* var. *paucipilus*). Other components include blue

grama, buffalograss, prairie sandreed *(Calamovilfa longifolia)*, sand lovegrass, prairie sunflower *(Helianthus petiolaris)*, foxtail barley *(Hordium jubatum)*, switchgrass, blowoutgrass *(Redfieldia flexuosa)*, sand dropseed, needleandthread, and small soapweed.

Grama-Needlegrass-Wheatgrass *(Bouteloua-Stipa-Agropyron)* is located immediately east of the Rocky Mountains in Alberta, Montana, and Wyoming. Dominants are blue grama, needleandthread, and western wheatgrass. Other components include bluebunch wheatgrass, fringed sagewort *(Artemisia frigida)*, threadleaf sedge, hairy goldaster *(Chrysopsis villosa)*, prairie junegrass *(Koeleria pyramidata)*, dotted gayfeather, plains muhly *(Muhlenbergia cuspidata)*, sandberg bluegrass *(Poa sandbergii)*, little bluestem, sand dropseed, green needlegrass *(Stipa viridula)*, and broom snakeweed *(Xanthocephalum sarothrae)*.

Wheatgrass-Needlegrass *(Agropyron-Stipa)* is directly east of the Grama-Needlegrass-Wheatgrass vegetation type. Dominants are western wheatgrass, needleandthread, and green needlegrass. Other important components are slender wheatgrass *(Agropyron trachycaulum)*, pussytoes (*Antennaria* spp.), fringed sagewort, sedges, prairie junegrass, indian ricegrass *(Oryzopsis hymenoides)*, penstemons (*Penstemon* spp.), little bluestem, cudweed sagewort *(Artemisia ludoviciana)*, heath aster *(Aster ericoides)*, black samson, dotted gayfeather, silverleaf scurfpea *(Psoralea argophylla)*, goldenrods (*Solidago* spp.), and porcupinegrass *(Stipa spartea)*.

The Wheatgrass-Bluestem-Needlegrass *(Agropyron-Andropogon-Stipa)* vegetation type is located in a narrow band along the eastern edge of the Mixed Grassland. The dominants are western wheatgrass, big bluestem, and porcupinegrass. Other important components are slender wheatgrass, little bluestem, fringed sagewort, heath aster *(Aster ericoides)*, cudweed sagewort, sideoats grama, blue grama, black samson, prairie junegrass, dotted gayfeather, silverleaf scurfpea, wild rose *(Rosa arkansana)*, prairie goldenrod *(Solidago missouriensis)*, needleandthread, and green needlegrass.

Tall Grassland

Tall Grassland includes three important vegetation types. The Bluestem Prairie *(Andropogon-Panicum-Sorghastrum)* is sometimes called the True Prairie. The dominants are big bluestem, little bluestem, switchgrass, and indiangrass. Other components are leadplant, pussytoes, heath aster, blue aster *(Aster laevis)*, wild indigos (*Baptisia* spp.), sideoats grama, daisy fleabane *(Erigeron strigosus)*, small bedstraw *(Galium trifidum)*, sunflowers (*Helianthus* spp.), prairie junegrass, gayfeathers (*Liatris* spp.), scurfpeas (*Psoralea* spp.), prairie coneflowers (*Ratibida* spp.), wild rose, compassplant *(Silphium laciniatum)*, goldenrods, prairie dropseed *(Sporobolus heterolepis)*, and porcupinegrass. The Bluestem Prairie is located from northwest Minnesota into northeast Oklahoma. Except for the Flint Hills region in Kansas and adjacent Osage Hills in Oklahoma, most is under cultivation.

Nebraska Sandhills Prairie *(Andropogon-Calamovilfa)* occurs in north-central Nebraska. Due to the soil-water relationships, this area supports tall grasses even though receiving precipitation that would normally support only mid grasses. Dominants are sand bluestem, prairie sandreed, switchgrass, little bluestem, and needleandthread. Other important species are big bluestem, sand lovegrass, indian ricegrass, sand dropseed, daleas, and scurfpeas. Most of this area remains in native vegetation. The development of center-pivot irrigation made it possible to grow corn and other crops in the Sandhills. Many acres of highly erodible soils were plowed. Lowered grain prices and increased energy charges caused the abandonment of many fields (Oldfather 1984). Blackland Prairie *(Schizachyrium-Stipa)* is located along the southeastern edge of the Great Plains. The dominants are little bluestem and Texas wintergrass. Other important species are big bluestem, red threeawn, sideoats grama, switchgrass, indiangrass, tall dropseed, silver bluestem, and buffalograss.

Factors Influencing Vegetation

Composition of the vegetation is due to the combination, in varying patterns, of the separate individual distributions of all plants. But, vegetation is far more than a mere grouping of individual plants. It is the result of interactions of numerous factors. Distribution of individual species, as well as the location of each individual plant, is determined by a complex set of environmental factors (French 1979). The most important climatic factor is precipitation. Water is the primary limiting factor on grasslands. Precipitation, therefore, directly controls the type of vegetation a site will support. The true prairie receives enough total precipitation to support forests; however, uneven seasonal distributions tend to preclude forest establishment (Gleason and Cronquist 1964). Fire, the pyric factor, has also been historically responsible for helping to maintain the prairie vegetation, particularly near its eastern boundaries where precipitation is less limiting. Native grasses and forbs are adapted to fire, while woody vegetation is not (Wright and Bailey 1982).

Physiographic factors, such as topography, locally influence vegetation. Edaphic factors may control which species occur in an area. Fertility of the soil is directly related to the productive capacity of the area. Some important species are seldom found on coarse textured soils, such as sands. Others may only be found on coarse sands. Soil texture and structure are also related to water infiltration and water holding capacity. Biotic factors influence the distribution of plants. A broad spectrum of living organisms are found in grasslands. The final consideration is the anthropic factor. Man's activities are responsible for the current conditions of grasslands and prairies.

Complex combinations of these factors influence rate of succession by influencing chance, selection, and modification (Gleason and Cronquist 1964). The final result is climax vegeta-

tion--that which is in a state of equilibrium with its climate and soils (Billings 1978, Daubenmire 1968). The factors of the environment are dynamic and cause the vegetation to be dynamic.

Origin of Grasslands

Current distributions of plants cannot be totally explained by the current factors of the environment. Several questions need to be answered. How have plants attained the range that they now occupy? Have they always been there? Did they evolve all over their present range? In order to obtain the answers to these questions, paleoecological events influencing plant distribution must be explored.

Paleoecological Events

The Rocky Mountains first arose about 135 million years ago during the Mesizoic Era and then eroded, forming a plain to where the Mississippi River is now located. Flowering plants became successful about 110 million years ago, and the first grasses evolved about 65 million years ago (Raven and Axelford 1974). A temperate forest occupied the Great Plains during the Eocene (about 60 million years ago) when the climate was warm and moist. The Rocky Mountains then arose a second time during the Oligocene (about 30 million years ago). The mountains intercepted the moisture-laden winds from the Pacific, and caused a rain shadow to the east (Dix 1964). The climate was warm and tropical grasslands, forerunners of modern grasslands, started to develop. Miocene deposits (about 20 million years ago)[4] in Colorado have yielded grass parts that have been assigned to the genus *Stipa* (Gould and Shaw 1983). Grass pollen has been identified numerous times from this same period which confirms this as the period of evolution.

Glaciation

Additional changes occurred during glaciation in the Pleistocene. Four periods of glaciation begin with the Nebraskan about 300,000 years ago. It was followed by the Kansan and the Illinois. The Wisconsin was the most recent, occurring only 10,000 to 60,000 years ago (Dorf 1960). Increasing cold and the slow southward movement of the glaciers caused the wheatgrasses, needlegrasses, and other cool-season species of northern origin to slowly spread to the south and southwest. Upon retreat of the glaciers toward the polar cap during the long, warm, dry interglacial periods, these species moved back northward. But some remained in the south. The warm-season grasses that originated in the southwest and what is now Mexico also moved northward during the interglacial periods. The movement of the glaciers caused the mixing of many species. Numerous relics from glaciation may be seen today. The eastern edge of the Black Hills in South Dakota and the north facing slopes along the Niobrara River in Nebraska contain examples of eastern deciduous forests. Another example is the presence of maples (*Acer* spp.), normally found in the forests of Ohio, in Caddo Canyon in westcentral Oklahoma.

Thermal Maximum

Thermal Maximum occurred from about 7,000 to 4,000 years before the present (Bryson et al. 1970). Temperatures during this period were 1 or 2°C higher than they are today, and warm-season grasses were able to migrate into the northern Great Plains. Some of the cool-season species were eliminated from the southern areas.

Little Ice Age

The Little Ice Age covers the period of 300 to 400 years before the present (Bryson et al. 1970). Temperatures were about 1 degree celcius cooler than in the present. It was the coldest period since man started to record weather conditions. Harbors froze farther south, and the growing season was greatly reduced. Warm-season plants less tolerant of cold and those requiring longer frost-free periods to reproduce were eliminated from the northern Great Plains. This period did not last long enough for cool-season plants to make significant advances southward.

Drought

Drought is a natural part of the environment of the Great Plains. Weakly (1962) constructed a drought history of the Great Plains using dendrochronology. He recorded over 20 droughts of five or more years in duration during the previous 750 years. Scientists are most familiar with the effects of the drought of the 1930s on grasslands (Albertson and Weaver 1942, Weaver and Albertson 1936).

The drought devastated the grasslands. In only seven years, the eastern boundary of the Mixed Prairie moved 100 miles east at the expense of the True Prairie (Weaver 1954). In just two years, one-third of the vegetation in the True Prairie was dead. In some areas, all of the indiangrass and big bluestem were gone, leaving the shorter sideoats grama and blue grama. From 80 to 90% of the plants were lost on some prairies. Losses of taller plants usually caused a chain reaction loss of understory plants. When the taller plants died, the understory plants could not tolerate the heat and light that penetrated the canopy. Losses were greatest where animals were allowed access (Albertson and

[4]*We have difficulty in understanding such long periods of time. Let's consider time-lapse photography to help understand the length of time represented by 20 million years. We will take one frame of film each 25 years. Then we will show the film at the rate of 16 frames/second, or 400 years/second. It would take nearly 14 hours to show the film.*

Weaver 1942). Not all plants decreased. Western wheatgrass and a few other species increased by utilizing moisture in early spring before most other species began growth.

Much like the warm interglacial periods, the drought of the 1930's permanently changed the vegetation (Stubbendieck et al. 1982). It has not been the same since, and probably will never be. The drought of the 1930's was recorded in tree rings as having a duration of ten years. Of the 21 droughts reported by Weakly (1962), 11 were of longer duration than 10 years. One was 38 years in length. One can only speculate as to the influence that a drought of this duration would have on the native vegetation.

Herbivores

Evolution of Native Herbivores

By the late Paleocene, several families of mammals were largely herbivorous (Van Valen and Sloan 1966). Competition among herbivores for available vegetation was probably a dominant factor controlling the rate of animal evolution. The Miocene Epoch was a period of world-wide upheaval resulting in extinction of many species, and considerable faunal exchange occurred between North America and Eurasia (Simpson 1947). A great diversity of grazing animals are preserved from the Miocene. Teeth of the plains dwelling animals of this time show a change from browsing to grazing. High crowned teeth evolved that continued to grow in response to the wearing of teeth by the grasses, which had a high silica content. Specialization to lengthen stride also occurred (Vaughn 1972).

The Pleiocene was more stable than the Miocene (Kurten 1972). The Great Plains savanna supported three-toed, two-toed, and single-toed horses in addition to camels, elephants, antelope, rhinoceros, and peccaries. The Pleistocene mammals that followed were even more abundant and diverse (Schultz and Martin 1970). It was also a period of faunal interchange between the continents (Simpson 1947). Mammoths became abundant as did deer and bovids.

Just as the current vegetation evolved during the periods of glaciation and interglacial periods, so evolved the grassland fauna as we know it today. Large and rather sudden changes occurred near the end of the Pleistocene (about 11,000 years ago). Horses, giant ground sloths, and mammoths disappeared in a rather short period of time (Martin 1975). The early bison *(Bison occidentalis)* became extinct about 8,000 years ago (McHugh 1972). The reasons are not known. Some feel that it was hunting pressure, but others point out inconsistencies in these theories (Grayson 1977, Martin 1975). The result was a continuing lack of diversity of large grazing mammals which is unlike any other time during evolution. The effect of these extinctions on energy flow will never be known. Probably more energy flows directly to decomposers now than before (Risser et al. 1981). Some herbivores survived and flourished. Bison *(Bison bison)*, elk *(Cervus canadensis)*, mule deer *(Odocoileus hemionus)*, and pronghorn *(Antilocarpa americana)* expanded to the large numbers that early naturalists and travelers saw and described (Allen 1871).

The number of bison on the plains before settlement has been an item of debate among both historians and scientists. Estimates vary from 30 to 125 million (Gunderson 1985, McHugh 1972, Roe 1951). The estimates have decreased as our knowledge of carrying capacities have become more complete.

Numerous other species of herbivores evolved in the grasslands; some to become extinct (McKeena 1969, Shultz and Martin 1970, Van Valen and Sloan 1966). Rodents and lagomorphs, however, were successful and abundant throughout the evolution of the grasslands.

Less information is available about invertebrates. Insects on what is now the Great Plains date from the Permean, but fossil records from the Pleistocene and earlier are not complete. Many diverse species of invertebrates coevolved with the grassland vegetation (Risser et al. 1981, Ross 1970).

Impact of Native Herbivores

Vegetation on the Great Plains evolved under periodic heavy use followed by periods of rest and recovery. Morphology and life history strategies of most grassland species are adapted for survival under grazing pressure from herbivores (Weaver and Clements 1938). However, not all plants of the same life form respond correspondingly to grazing, as has been shown by some of the classic range management research (Dyksterhuis 1949, Smith 1940, Tomanek et al. 1958).

Heavy use by bison was common around watering sites, salt licks, and calving grounds; nonetheless, there were few long-term effects on the vegetation in terms of depletion (Stewart 1936). The herds were nomadic (Roe 1951), and when vegetation was fully utilized on one site, the bison moved to another, allowing it to recover.

Large populations of other mammals and invertebrates also exerted heavy cyclic pressure on the vegetation. When forage was no longer available, they moved or their numbers greatly decreased. Hence, the vegetation received a period of rest during which it recovered. The extinction of many Great Plains herbivores in the Pleistocene is, in the same manner, partially responsible for the period of rest required for recovery of its vegetation.

This is a simplified view of the impact of herbivores. Climatic variables and fire would be prominent factors affecting not only the movements of animals, but also the vegetation. When all of the other factors are combined, the Great Plains ecosystem becomes extremely complex, but it was in balance. An important point is that vegetation on the Great Plains evolved with use. Plant materials did not accumulate on the soil surface for long periods of time. Herbage not consumed by herbivores was consumed by fire.

Human Interactions

Early Man's Impact

Man crossed the Bering Strait into North America during the Wisconsin glacial period. He dispersed across the continent in a few thousand years. Population numbers were never high in most areas of the Great Plains. Were these early inhabitants simply a part of the natural ecosystem? Probably not. They may have been the force for extinction of some animals, but numbers of these animals were probably low when man arrived. Hunting abilities increased with acquisition of horses from Spanish explorers in the 16th century. Many could venture farther into the plains to hunt and live. During the few hundred years they had horses, the American Indians may have killed 3 million bison each year, hardly enough to affect adversely the bison population. But man's extensive use of fire removes him from the category of a biotic factor and places him in the anthropic category.

Great Plains of 150 Years Ago

The Great Plains of 1837 was a broad expanse of grassland. The vegetation was not uniform, but it generally intergraded in wide ecotones. For the most part it was treeless because of the xeric climate and fire. The fauna most notably included large herds of nomadic bison. Other ungulates were common, but not as numerous. Invertebrates flourished in cycles. The soils were still virgin, having not yet felt the bite of a plow. American Indians were relatively numerous in only a few locations. It was a complex, dynamic, natural ecosystem.

Early Explorers, Cattlemen, and Farmers

First and second generation Europeans had been raised in or near forests and did not understand the concept of a broad, treeless prairie. John C. Fremont (1845) reported that the plains were a novelty that excited Asiatic, not American, ideas: "It is difficult to picture those scenes of Asian wilderness within our natural borders. From childhood, we have so linked descriptions of piles of scorial and treeless, grassless slopes with dimmest legends of the olden time that we cannot will persuade ourselves that such things are American realities" (Greene 1856).

Large numbers of settlers first entered the Great Plains after the Civil War. The bison were largely eliminated within 15 to 20 years, partially as a means of controlling the American Indians.

Barbed wire became widely available in the 1870's. Settlers soon fenced their land and left their animals on the range continuously. The vegetation quickly began to deteriorate because it was not allowed to rest after grazing. Numbers of domestic animals were allowed to increase while cultivation removed part of the grazing resource.

The frequent result was deterioration of the vegetation. The domestic animals themselves were not the problem. Domestic livestock did not constitute a new biological process. Their grazing habits were not greatly different than that of the bison. The problem was one of too many animals left continuously on the range without a chance for recovery of the vegetation.

Modern range management developed following the dought of the 1930's. Information gained through research and experience has enabled managers to develop methods to properly utilize the vegetation. Much of the vegetation of the Great Plains has recovered from degraded conditions caused by previous management.

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Establishment of Range Plants in the Northern Great Plains

R. E. Reis, R. S. White and R. J. Lorenz[1]

Abstract.--The 1985 Food Security Act instituted the Conservation Reserve Program (CRP). This program provides economic incentives to plant highly erodible cropland back into grasses, forbs, shrubs or trees. Through the fifth signup, about 3.8 million acres (1.5 million ha) in the Northern Great Plains have been accepted for seeding under CRP. A review of information concerning problems and techniques of establishing range plants in the Northern Plains is provided.

The Great Plains region of North American encompasses the southern Canadian provinces of Manitoba, Saskatchewan, and Alberta, south through the central part of the United States to the Mexican border and the Gulf of Mexico. For this paper, the northern portion of the Great Plains as delineated by Norum et al. (1957) (fig. 1) is considered as the Northern Plains.

Soils of the Northern Plains are composed of chernozem soils on the east, chestnut soils in the center, and brown soils on the west (table 1). Soil depths decrease from east to west (Buckman and Brady 1969).

Climate of this area is distinctly continental. The portion lying east of a north-south line from central North Dakota into Nebraska is considered to be part of the subhumid region of the United States, while the portion west of the same line is considered part of the semiarid region (U.S. Department of Agriculture 1941, Bailey 1980). Average annual precipitation within the Northern Great Plains ranges from 10 to 20 in. (25-51 cm) with approximately 75% occurring during the months of April through September (fig. 2). Mean annual temperatures range from 35 to 50 F (1.7 - 10 C) (fig. 2). Mean annual pan evaporation within the Northern Great Plains increases from a low of 35 in. (89 cm) in the northeast to a high of 65 in. (165 cm) in the southwest (U.S. Department of Commerce 1968) (fig. 2).

The native grassland ecosystem of the Northern Plains developed under the climatic conditions outlined above. Stubbendieck has described the vegetation more completely in these Proceedings. The true tall grass prairie was found in the eastern portion of North Dakota in the Red River Valley (fig. 3). Dominant species included big bluestem *(Andropogon gerardi)*, little bluestem *(Schizachyrium scoparium)*, switchgrass *(Panicum virgatum)*, Indian grass *(Sorghastrum nutans)*, and sideoats grama *(Bouteloua curtipendula)*. The remainder of the region was originally mixed-grass plains (Sims and Coupland 1979) (fig. 3). Major species included blue grama *(Bouteloua gracilis)*, western wheatgrass *(Agropyron smithii)*, needle-and-thread grass *(Stipa comata)*, green needlegrass *(S. viridula)*, buffalograss *(Buchloe dactyloides)*, and prairie junegrass *(Koeleria cristata)*.

The natural vegetation has been greatly altered by man. Only remnants of the true tall-grass prairie are left intermixed with cropland, and part of the mixed grass area has also been plowed for wheat production. In the spring wheat region, characterized by gentle topography (fig. 3), wheat crops are integrated with forage crops for livestock. Depending upon the market price for wheat and livestock, more land is allocated to wheat or cattle in order to increase revenues (Lorenz 1977). The plowing of grass for wheat crops is common when wheat prices are high, followed

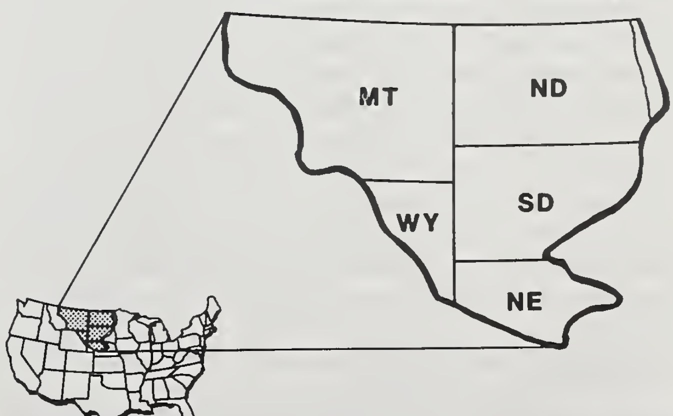

Figure 1.--Northern Great Plains region (after Norum et al. 1957).

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Table 1.--The 1938 soil classification system with approximate equivalents in present classification system.

1938 system	Present system[1]
Chernozems	primarily--Cryoborolls; mesic families of typic and udic subgroups of Argiustolls and Halpustolls; udic subgroups of Argiborolls and Haploborolls.
Chestnut soils	primarily--Frigid families of Argixerolls, Durixerolls, Haploxerolls, and Palexerolls; mesic families of aridic subgroups of Argiustolls, Argixerolls, Haploxerolls, and Haplustolls; typic subgroups of Argiborolls and Haploborolls.
Brown soils	primarily--Mesic families of aridic subgroups of argiustolls, Argixerolls, Haploxerolls, and Haplustrolls; mesic families of ustollic and zerollic subgroups of Argids and Orthids.

[1]*Soil Survey Staff. 1975. Soil Taxonomy. p. 433. Agriculture Handbook No. 436. Washington, D.C.*

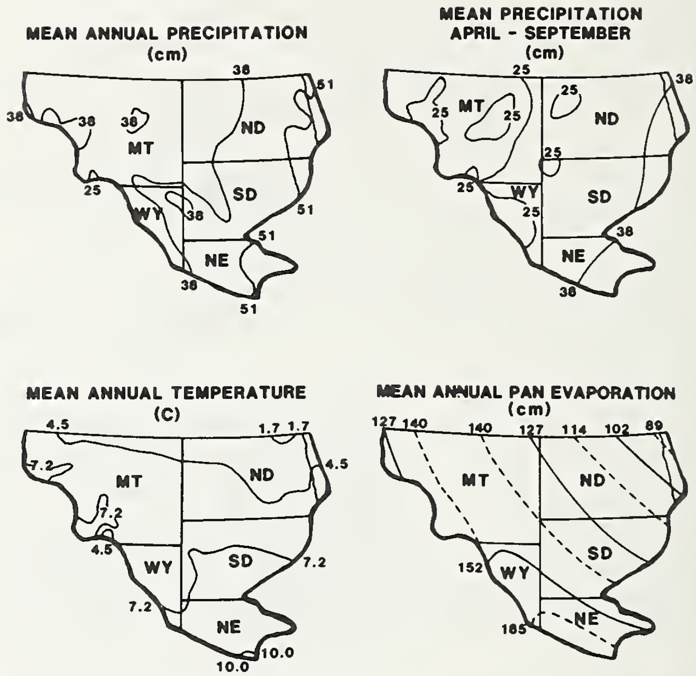

Figure 2.--Climatic summary of the Northern Great Plains (U.S. Department of Agriculture 1941 and U.S. Department of Commerce 1968).

by the reestablishment of grass for forage when livestock prices provide better revenues. In this integrated system, the timely reestablishment of grass is important to protect the soil resource from excessive erosion and to shorten the time required to increase livestock production.

The rangeland region of the Northern Plains has rougher topography and is found in the eastern part of Montana, western South Dakota, and northeastern Wyoming (fig. 3). While some dryland agriculture can be found in this region, the growing season climate is hot and dry and soils are shallow and erodible and, therefore, marginal for crop production. Range plant production for livestock and wildlife appears to be the best land use. Pasture and rangeland are very important in the Northern Plains region because they provide an economic return from these marginal lands. Private pasture and rangelands along with leased public rangeland are operated together to provide economic livestock operations on land with little other economic potential. Currently, more than 100 million acres (40 million ha) over 60% of the total land in the region, are used for pasture and rangeland.[2]

During the late 1970s and early 1980s there was an increase in the conversion of native grassland to cropland within the Northern Plains. The Soil Conservation Service (SCS) in South Dakota recorded the conversion of over 1,033,500 acres (413,400 ha) of native grassland to cropland from July 1, 1974 through June 30, 1986.[3] Since these converted grasslands are often marginal for crop production and can be highly erodible, such land use changes have increased accelerated soil erosion and threatened the productive capacity of these lands for any use. Legislation, commonly known as the 1985 Food Security Act with sodbuster provisions, was recently passed as a means of reducing the conversion of native grasslands to marginal croplands. The Bill also instituted a new program called the Conservation Reserve Program (CRP) which provides economic incentives to plant highly erosive croplands back to grasses, forbs, shrubs, and trees. The main proposed benefit from this program is to conserve the Nation's soil resource.

With the initiation of the CRP, there has been a dramatic increase in grass seedings in the Northern Plains. About 3.8 million acres (1.5 million ha) have been accepted for the CRP through the fifth signup period within this region (personal communication August 1987, with USDA-SCS State Resource

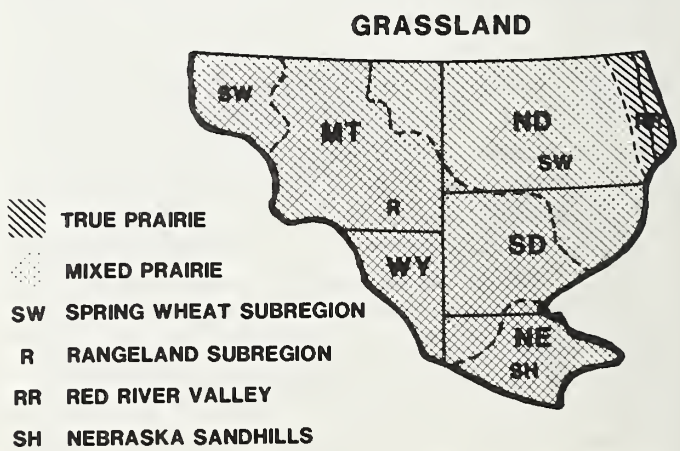

Figure 3.--Original vegetation and land use of the Northern Great Plains (adapted after Sims and Coupland 1979 and Norum et al. 1957).

[2]*U.S. Department of Agriculture. 1987. The Second RCA Appraisal-Public Review Draft. Washington, D.C.*

[3]*U.S. Department of Agriculture, Soil Conservation Service. 1986. Estimated land use conversions, grassland to cropland, July 1, 1985-June 30, 1986, South Dakota, Huron.*

Conservationists--Myron Senechal, ND; Dwayne Breyer, SD; Robert Lohmiller, MT; Lionel Young, WY; and William Hance, NE). This has stimulated demand for more useful information concerning the best techniques for seeding and planting range plants. The purpose of this paper is to discuss principles and techniques for establishing range forage species in the Northern Plains.

Range Plant Establishment

Planning for Seeding

Any seeding effort requires good planning. Items such as the purpose of the new seeding, selection of species, cultivars, or species mixture, and selection of proper seeding methods and time should be considered. Once a plan is formulated it should be carefully executed.

The ultimate use of the seeded plants should determine the plant species to be selected. In the Northern Plains, grasses will be of primary importance, with forbs, shrubs and trees having a secondary role in special situations. There are many plant species and cultivars suitable for seeding or planting in this region. Final selection will be dependent on the specific location where the seeding or planting will take place. Plant species are not equally suited for all environmental conditions or uses; therefore, it is important to select the species and cultivars best suited for the specific use and environment.

Monocultures or a mixture of species may be seeded. Likewise, there is a place for both native and adapted introduced species in seeding. For example, a monoculture of crested wheatgrass *(Agropyron cristatum* or *A. desertorum)* may serve well for early, spring pasture. Alternatively, a broad mixture of slender wheatgrass *(Agropyron trachycaulum)*, western wheatgrass, green needle-grass, sideoats grama, and blue grama may be desired for a diverse stand that will be grazed seasonal-long.

After the species or mixture of species have been selected for a particular seeding, care must be taken to assure the seed obtained is of good quality, weed free, and from a location geographically and environmentally similar to the location where the seeding will be made. Information on plant species adaptation and selection is available in the literature (Vallentine 1980) and from Soil Conservation Service field offices.

Techniques for Seeding Range Plants

Information on seeding and planting techniques has generally been written for specific locations since localized conditions will necessitate slight modification of general techniques. Vallentine (1980) and Decker et al. (1973) have provided broadly applicable general information on seeding and planting techniques. Similar information on a more localized basis for specific parts of the Northern Plains is also available. Short (1943) provided an in-depth discussion of seeding practices in Montana. McWilliams (1955), Dietrich (1965), and Dodds and Meyer (1974) discussed research results and seeding techniques for North Dakota. Lang et al. (1975) discussed techniques for seeding dryland range, pastures, and disturbed land in Wyoming. Derscheid et al. (n.d.) discussed planting tame pasture and hayland in South Dakota.

Seedbed Preparation

The first field operation in any seeding will be seedbed preparation. Seedbeds are often clean-tilled land that is fallowed prior to seeding or clean stubble land. Seedbed preparation can be completed with conventional farming equipment such as plows, disks, or field cultivators. When seeding into clean-tilled land, primary and secondary tillage should result in a weed-free, firm, and relatively smooth seedbed. More rough seedbeds have been used in conjunction with broadcast seeding. Seeding directly into stubble has been a common practice since the 1940s. Seeding into stubble is a desirable technique since it is less expensive, and the stubble and crop residue provide for soil protection from wind and water erosion while new seedings are being established. Stubble seeding methods have been improved by the development of no-till drilling equipment.

However, under certain conditions, yet to be defined, seeded crops and grasses have been adversely affected by this practice. Elliott and Cheng (1987) assessed allelopathy among microbes and plants, and pointed out two ways seeded plants may be affected. First is from the direct production of toxins by microbes, and the second is by toxic molecules produced during microbial decomposition of organic crop residues. Both of these have been difficult to demonstrate, mechanistically. Conclusive evidence is evasive because interacting environmental factors regulating the allelopathic relationship, such as soil water and temperature, are difficult to characterize and incorporate into a model of what really is occurring. McWilliams (1955) seeded grasses into 8 to 10 in. (20 to 25 cm) wheat stubble without seedbed preparation at Mandan, ND in the years 1942 through 1948 and did not report any problem from the residual stubble. As Mitchell and Evans point out in this Proceedings, more detailed information is still needed to understand the situation pertaining to phytotoxins in small grain stubble.

Seeding Methods

Grain or grass drills equipped with depth bands and packer wheels have been by far the most successful means for seeding grasses and forbs in the Northern Plains. Depth bands prevent placement of the seed too deeply into the soil, while packer wheels insure good seed to soil contact. New drills have been developed that improve the accurate seeding of fluffy seed. No-

till drills have made seeding directly into stubble more effective through better seed depth control even through crop residues.

Depth of planting is generally proportional to the size of the seed being planted. Depths of 0.5 in. (1.3 cm) or less have been used for small seeds such as blue grama, while depths of 0.75 to 1.0 in. (1.9 to 2.5 cm) have been used for larger seeds like western wheatgrass. McWilliams (1955) studied planting depths of 0.5, 1.0, and 1.5 in. (1.3, 2.5, and 3.8 cm) for cool-season grasses at Mandan, ND, during the 1940s. He found that the cool-season grasses [crested wheatgrass, western wheatgrass, smooth bromegrass *(Bromus inermis)*, Canada wildrye *(Elymus canadensis)*, Russian wildrye *(E. junceus)*, and green needlegrass] produce satisfactory stands when seeded at depths of 0.5 to 1.0. in. Some species produced better stands when seeded at 1 in. in the spring. Poor stands resulted from all plantings deeper than 1 in. Warm-season grasses were seeded at 0.25, 0.5, 0.75, and 1.0 in. (0.6, 1.3, and 2.5 cm). Satisfactory stands of warm-season grasses (blue grama, sideoats grama, switchgrass, and big bluestem) resulted from planting depths of 0.25 and 0.5 in., but poorer stands resulted from planting depths greater than 1 in.

Drill row spacing has generally varied from 6 to 12 in. (15 to 30 cm). Wider row spacings are generally used in the western part of the Northern Plains where moisture is more limiting. Proper row spacing is important to minimize inter- and intra-species competition for soil water.

In some cases, seedlings have been successfully established when seed was broadcast over an area. However, this method is not generally recommended. Seedbeds for broadcast seeding can be rougher and less firm; hence, this method may be the only feasible way to seed steep, rough areas. Some method of mechanical seed covering, such as the use of a soil drag or cultipacker, is highly recommended for broadcast seeded areas to aid in seed coverage and seed/soil contact.

Interseeding has been used with some success in the Northern Plains. In this method, new species are introduced into existing vegetation by seeding rows of the new species following chemical or mechanical seedbed preparation. This technique has been used to introduce forbs, primarily dryland alfalfa *(Medicago sativa)*, into rangeland communities.

Transplanting plants into localized, prepared areas has been used for shrub and tree plantings. Transplants of bare-root or containerized seedlings of shrubs and trees are costly, but have provided some success in getting these plant groups established on localized, suitable sites.

Seeding Dates

The time of seeding is an important factor to the success of any dryland seeding or planting. Basically, the time should be just prior to the greatest probability for favorable precipitation and temperatures to support plant species germination, emergence, and establishment. Achieving this seeding date is fortuitous in the Northern Plains because of variable weather conditions. Periods of drought can occur during any of the recommended seeding periods and can adversely affect the success of establishment. Usually, cool-season plants can be successfully seeded in fall (September - October) and early spring (April).

Warm-season plants should be seeded from late April to early May. Warm-season grasses established the best stands when seeded between April 20 and May 10, while later plantings resulted in poor stands (McWilliams 1955). Shrubs and trees are also usually planted in late April and early May.

All cool-season grasses, except for western wheatgrass, establish the best stands when seeded in early to mid-September; however, western wheatgrass stands are best when seeded in mid-October (McWilliams 1955).

Seeding Rates

Seeding rates in the Northern Plains vary with local conditions and previous experience of the seeder. Perennial grasses are seeded from 18 to 147 per live seed (pls) per ft.^{2} (200 to 1600 pls m^2). This translates from 5 to 35 lb./ac. (6 to 39 kg/ha). Broadcast seeding requires increased seeding rates.

Seeding rates affect both stand establishment and forage yield of warm- and cool-season grasses (McWilliams 1955). Seeding rates of 8 to 10 lb./ac. (9 to 11 kg/ha) produced satisfactory stands for all species, both in stand establishment and forage yield. Heavier rates 12 to 15 lb./ac. (13 to 17 kg/ha) resulted in forage yield sufficient to warrant their use for green needlegrass.

Early Stand Management

Proper management during and after seeding is crucial to insure success. Unless fertility levels are extremely deficient, fertilization at seeding does not appear to increase stand densities. The addition of nitrogen and phosphorus the second growing season may insure vigorous growing seedlings. Fertilizer must be used carefully, however, because weeds in the stand will become more competitive with fertilizer.

Weed control is sometimes needed to reduce weed competition with the establishing seedlings. Competition for water and light can reduce the success of the new seedlings. Chemicals are available for controlling broadleaf weeds after grass seedlings have emerged or reached a certain leaf stage. Mechanical mowing of the weedy species just above the establishing grass seedlings has also been successful. Cultivation is a common practice around planted shrubs and trees to reduce weed competition. Competition from weeds can be more severe in periods of adverse weather conditions such as low rainfall.

Initially, new seedlings should be protected from livestock grazing. Controlled grazing or haying of stands during the second and third growing season can be done under most circumstances. However, grazing should be carefully controlled so damage to the young seedlings does not occur. Haying of newly seeded stands should occur when the new seedlings have completed their

phenological development in order to lessen damage. Obviously, lands placed in the CRP are not available for haying or grazing during their 10-year contract periods.

When new stands are established, it must be understood that these stands are dynamic and plant succession will take place. Fertilizer application, grazing, mowing, and burning are tools that can be used to improve these initial stands and even change plant species composition as they develop. Fertilizer application or excess residue removal may enhance the vigor of the new stands. Early spring grazing can reduce the cool-season component of a stand in favor of the warm-season species. Likewise, the timely application of nitrogen early in the spring can favor the cool-season species over the warm-season species. The uses of these management tools should not be overlooked when they can enhance the newly developing stands.

This has been an overview of seeding and planting information for range plants in the Northern Plains. While information exists, more detailed research concerning the environmental effect on current seeding methods is needed. Guidelines for plant species selection and seeding and planting techniques for various soils and climatic conditions are available from Soil Conservation Service field offices.

Summary

A review of grass seeding results in the Great Plains was conducted by the Great Plains Council (1966). Data from this report for Resource Areas found in the Northern Plains show that, out of 1390 seedings, 72% resulted in stands with 1.0 or more plants per ft.^{2} (10.8 or more plants per m^2) and 28% had less than this density. This shows that, while seedings are more successful in the Northern Plains than the Central or Southern Plains, failures can still be expected.

In seedings or plantings, every effort should be made to use good planning and proper techniques. Controllable factors are; species and cultivar selection, seed quality, seedbed preparation, seeding method with appropriate rate and depth, seeding date, and early stand management. However, weather conditions are uncontrollable. The best chance to mitigate unfavorable weather is with proper plant species selection and seeding dates that will take advantage of the most probable favorable weather conditions for plant establishment.

No matter what we do, we will have to live with the weather conditions of the semiarid region which encompasses most of the Northern Plains. C. Warren Thornthwaite described it best in the following statement: "In a desert, you know what to expect of the climate and plan accordingly. The same is true of the humid regions. Men have been badly fooled by the semiarid regions because they are sometimes humid, sometimes desert, and sometimes a cross between the two..." This is the situation in most of the Northern Plains area and is of primary importance to successful plant establishment.

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2-6

Establishment of Native and Introduced Range Plants in the Central Great Plains

William J. McGinnies and Wendell G. Hassell[1]

Abstract.--Successful establishment of grass seedings in the Central Plains is an uncertain process because of low and unreliable precipitation, hot summer temperatures, competition from weeds, and losses due to insects and disease. Proper seedbed preparation and seeding practices can increase the likelihood of establishing a stand of range plants. Standards and specifications used by the Soil Conservation Service for seeding CRP lands are provided.

The Central Great Plains consists of Colorado east of the Rocky Mountains, Western Kansas, Western Nebraska and southwestern Wyoming. This region receives 10 to 22 in. of precipitation annually. Much of the region is marginal for crop production even when using the best agronomic practices. Greb (1979) pointed out that "Just because land is level and east of the Rocky Mountains does not imply that the climate at the place is suitable for sustained dryland agriculture. Some areas are too dry, too warm and too windy too often." The only certainties in the Central Great Plains are wind and recurring drought. These very same climatic factors that make dryland agriculture difficult in this region cause even more serious problems in establishing forage grasses.

During the period 1946 to 1975, failures in dryland wheat plantings averaged from less than 10 percent in portions of the eastern half of the Central Great Plains to over 40% in southeastern Colorado (Greb 1979). Similar data are not available for failures in grass seeding projects; however, our best estimate is that during an equivalent period at least 50% of the grass seedings could be expected to produce a stand of grass that would rate as less than completely satisfactory. Grass seeding failure rates are highest in areas that receive less than 15 in. average annual precipitation and in southeastern Colorado. Failures must be expected because of drought, lack of rainfall during critical growth periods, wind erosion, insects, poor seedbed preparation, weed competition, seed planted too deep or too shallow, seed washed out of deep-furrow drill rows not planted on the contour, wrong date of planting, seeding unadapted varieties, seedling diseases, or more commonly a combination of these factors. Carefully following proper seeding procedures can reduce the number of failures, but it cannot eliminate them, and failures do occur during seemingly ideal conditions.

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Although there are differences in specific regulations of the Conservation Reserve Program (CRP) regarding seeding methods and seedbed preparation among the various states, from the standpoint of general principals, seeding methods and procedures are essentially the same throughout the Central Plains region, and will be discussed for the region as a whole. Some seeding recommendations are site specific, and, in a later part of this paper, will be discussed for each major area within the region.

The Planning Process

Planning is the first and one of the most important steps in any seeding project. Unfortunately, it is a step that is frequently overlooked or not taken seriously. Plans should be detailed on paper, not just kept in mind, and important dates should be marked on the calendar. Planning for CRP projects is further complicated by the need to be aware of all of the applicable regulations and to complete all of the necessary paper work in order to receive full payment under the Program. Because regulations change periodically, one must be certain that only current regulations are followed.

The first step in planning is to determine where adequate financing for the project can be obtained. The exact planting procedures to be followed, the species to be planted, and the post-planting management of the seeding should be determined. Before the project is started, one must be certain that the desired procedures can be completed at the appropriate time, that an adequate supply of the desired varieties of seed will be on hand because seed of many species will be in short supply, and that suitable equipment for seedbed preparation and planting will be available and in good repair.

If a contractor is to do the seeding, arrangements should be made well in advance because the better contractors will have more work than they can readily handle. Fencing may be necessary to protect the seeding from livestock. Arrangements should be made to evaluate the success of the seeding as early in the season as practical and to have a contingency plan available for replanting in case of a stand failure.

Seedbed Preparation

A well prepared seedbed is much more critical for planting grasses than for planting small grains because of the need to precisely control seeding depth of the grasses. Moreover, the grass seedings, because of their relatively low vigor, need optimum soil moisture conditions near the surface for survival. The seedbed needs to be smooth enough to permit accurate depth control when planting the seed. It must be firm enough to provide good soil-seed contact, optimum soil water relations, and to provide support for the depth bands on the drill to prevent the seed from being planted too deeply (McGinnies 1962). At the same time, the seedbed must not be so hard that it prevents adequate penetration by the drill discs.

If possible, the seedbed should not be cultivated immediately before seeding because this will require that it be cultipacked to firm it up before planting. Cultipacking provides an unsatisfactory option because the packing action will also knock down or destroy stubble or mulch. However, where a stubble mulch is permitted, a shallow cultivation may still be the most practical way to control weeds and volunteer grain plants immediately before seeding.

If the seedbed does not already have a stubble on it, it will be necessary to establish one. The principle reasons for having a stubble are to reduce wind erosion and evaporation of water from the soil surface. Grain sorghum, Sudan grass or millet are the most commonly used crops for establishing stubble and should be planted at 10 to 14-in. row spacing. These should be mowed off before seed is formed to leave a standing stubble of about 12 in. Although the use of wheat stubble is restricted in some locations by current regulations, there is no evidence that it is any less satisfactory than other species for stubble. It is entirely satisfactory if some means is used to control the volunteer wheat. Where stubble mulch is permitted, tillage operations should be kept to a minimum and every effort should be made to keep the maximum amount of well-anchored litter on the surface.

The use of a nurse crop, including sweet clover, is not recommended. Nurse crops compete for soil water that would otherwise be available to the grass seedlings, and, thus, are more detrimental than beneficial for stand establishment. Stubble provides adequate protection for the seedbed and seedlings and makes a nurse crop unnecessary.

Weeds should be eliminated from the seedbed before seeding grasses. Weed control is important both for conservation of stored soil water and to avoid later competition with the grass seedlings. Weed control is best accomplished with a contact or pre-emergence herbicide; however, the herbicide must be one that will not leave a residual harmful to the grass seedlings. The Soil Conservation Service (SCS) has had good results with a pre-planting application of Glean, Ally or Roundup.[2] Herbicides can also be used to control volunteer plants in small grain stubble. Where a stubble mulch is to be used, a shallow pre-planting cultivation can be used to eliminate weeds and volunteer grain.

Seeding Techniques

Seeding rates will vary with the species and location, but in general the minimum rate will be near 20 pure live seeds per foot of seeded row (McGinnies 1970). Specific seeding rates for various locations and species will be presented later. Where care is taken in seedbed preparation and seeding technique, seeding rates may be lowered. With the present cost and unavailability of quality grass seed, it is important to do the best possible job of seeding so that the minimum practical seeding rates can be used. It is important to check the seed tag for germination and purity, and to adjust the seeding rate to a pure live seed basis.

Seeding rates are usually expressed as number of pure live seeds per foot of seeded row because this makes calibration of the drill much easier. Calibration can be accomplished by pulling the drill over a hard surface that the discs do not penetrate, counting the number of seeds dropped over a measured distance, and adjusting the drill feed mechanism until the desired rate is obtained. Accurate seeding rate calibration insures that an adequate amount of seed is planted, while at the same time avoids wasting scarce and costly seed.

Because of the small size of most grass seeds and the relatively low seedling vigor of most grass species, accurate control of seeding depths is one of the most critical factors for successful seedings. Generally, grass seed should be planted at least 1/2 in. deep to avoid the rapid soil drying near the surface, but seed should not be planted more than 1 in. deep because many grass seedlings will have difficulty emerging from a deeper depth (McGinnies 1973). Thus, except for special cases, the recommended planting depth for most grass species is 3/4 in. This depth allows for slight variations in seeding depth while still remaining within the 1/2 to 1-in. depth range.

Accurate control of seeding depth is best accomplished with a double-disc drill equipped with depth bands when used on a firm seedbed. If a deep-furrow drill is used, the planting depth in the bottom of the furrow should still be 3/4 of an inch. However, seed planted in a deep furrow may become covered too deeply because of soil sloughing or by wind or water deposited soil. Deep-furrow planting is usually unnecessary if a suitable mulch or stubble is used. Another problem encountered with deep-furrow planting is that if the furrows are not on or near contour, water can run down the furrow and wash out the seed.

[2]The use of trade and company names is for the benefit of the reader; such use does not constitute an official endorsement of the product by the U.S. Department of Agriculture to the exclusion of others that might be suitable.

Because of the need to plant grass seed with a high level of precision, the importance of using a suitable grass drill cannot be overemphasized. When planting free-flowing seed such as that of crested wheatgrass, a grain drill that uses a flute-feed system and is equipped with double-disc openers and depth bands can do a completely satisfactory job. However, if hairy, fluffy or trashy grass seed, e.g., blue grama *(Bouteloua gracilis)* or the bluestems (*Andropogon* spp.), is to be planted, a special grassland or rangeland drill will be needed. These drills have seed metering mechanisms that will uniformly feed seed that will not feed through a standard grain drill. Most are equipped with more than one seed box; the additional seed boxes meter out free-flowing seed and fine seeds such as legumes or the lovegrasses (*Eragrostis* spp.).

The ideal drill, then, has double-disc openers with depth band and should be capable of accurately delivering the desired rates of all the species to be planted into a wind-proof drop system to the very bottom of the small furrow opened by the discs, and then cover the seed and pack the soil over it with a packer-wheel. If the drill is also to be used for range seeding, it must be of extra sturdy construction. Grassland drills that meet all of these specifications are available from commercial sources.

While the modern grassland drill is capable of planting grass seed with great precision, it cannot accurately control planting depth when pulled at excessive speeds. These drills are designed to be operated at 3 to 3-1/2 miles per hour. The maximum speed at which they should be used is 4 miles per hour. At higher speeds, precision seeding is almost impossible. Four miles per hour is a very fast walking speed, so if one cannot readily walk along side of the drill when planting, the drill is going too fast. Contracts for seeding should specify that all drilling is to be done at speeds of less than 4 miles per hour.

Broadcast seeding is not recommended. If for some reason broadcast seeding must be used, seeding rates should be doubled or tripled, and some method must be used to cover the seed. The biggest problem with broadcast seeding is that it does not accurately control the planting depth of the seed. Most culti-packer-type seeders would be classified as broadcast seeders.

The ideal row spacing for most grass seeding in the Central Plains is 10 to 14 in. If the seeding is planted to a bunchgrass that is later to be harvested for hay, row spacings up to 18 in. may be an advantage because the wider row spacing will usually produce taller plants that are easier to harvest. Row spacings of less than 10 in. can result in low-growing plants that are more susceptible to drought damage.

If a grass-legume mixture is to be planted, it is best to seed the legume in alternate rows with the grasses (McGinnies and Townsend 1983). The grasses should be seeded at a 16 to 28-in. spacing with the legumes seeded between the rows of grass. This can be accomplished using a drill with 8 to 14-in. spacing and plugging every other seed drop in the grass box and then plugging the alternate drops in the legume box. If necessary, grasses and legumes can be seeded in the same row, but the alternate row system is preferred.

Applying fertilizer at the time of seeding is not recommended. Nitrogen fertilizer will encourage weed growth and the weeds will compete even more strongly with the grass seedings. One exception to this generality is where alfalfa will be planted on soils with a low phosphorus content. Under such conditions, it is usually desirable to add phosphorus.

Post-emergence weed control can be a great aid to seedling establishment, particularly if done early in the season before weeds can utilize available soil water (McGinnies 1968). Broadleaf weeds are readily controlled with 2,4-D; however, 2,4-D obviously cannot be used if a legume has been included in the seeded mixture. Spraying with 2,4-D will usually not damage grasses if the grass seedlings are past the three-leaf stage. In general, 2,4-D will not give satisfactory weed control unless the soil is moist and the weeds are growing vigorously. Mowing weeds may be of limited help, but generally by the time weeds are large enough to mow, they have probably already used up much of the soil water.

The seedling stand should also be watched for evidence of insect damage. Pesticide application may be necessary where substantial damage is possible. Particular attention should be given to the Russian wheat aphid in wheatgrass (*Agropyron* spp.) seedings particularly after it reaches maturity. As a general rule, if more than 10 to 20% of the plants become infested, a spray program to control the aphid should be initiated.

Effects of Temperature, Precipitation on Seedling Establishment

When selecting a seeding date, consideration must be given to species, soil moisture, seasonal precipitation, mulch cover, weed control and equipment availability. Rangeland and non-irrigated cropland seedings in the Central Plains are risky in any given year due to unpredictable precipitation patterns and hot summer temperatures common throughout this area. However, new technology and methods have added alternatives that were not available 20 years ago, including new cultivars with increased seedling vigor and herbicides for weed control.

Effective precipitation and frequency of rainfall events are of great concern when establishing plants. Research indicates two events of at least 0.2 in. within 2 to 5 days are generally required for germination with adequate soil temperatures. Less than 0.2 in. is of little significance due to rapid evaporation. After emergence, precipitation is needed within an estimated 5 to 8 days or seedlings will not survive. This period decreases to approximately 2 to 4 days when surface soil temperatures are above 90 F. As a result, the periodic 10 to 14 day dry periods common throughout the Central Plains cause a significant loss of seedlings.

In addition to precipitation, soil temperatures are critical for germination of some warm season grasses. Blue grama requires a soil temperature of 60 F at seed depth for good germination and it germinates more rapidly at higher temperatures (Wilson and Briske 1978). Other species, such as alkali sacaton *(Sporobolus*

Table 1.--Optimum germination temperatures for selected grass species as measured on a temperature gradient plate (from Sabo et al. 1979).

Species	Temp (°F)	Time (hrs)	Temp (°F)	Time (hrs)	Const. temp (°F)
Sand dropseed[1] *(Sporobolus cryptandrus)*	32	8	67	16	
Western wheatgrass[1] *(Agropyron smithii)*	50	16	65	8	
Sideoats grama *(Bouteloua curtipendula)*	53	8	88	16	73
Little bluestem *(Schizachyrium scoparius)*	61	16	81	8	
Galleta *(Hilaria jamesii)*	--	--	--	--	84
Blue grama *(Bouteloua gracilis)*	90	8	97°	16	

[1]*Light reported to be necessary.*

airoides) and Western wheatgrass *(Agropyron smithii)*, germinate at lower temperatures while galleta *(Hilaria jamesii)* favors warmer soil temperatures, as noted in table 1. In eastern Colorado, temperatures should be adequate for seed germination of warm season species by the latter part of April. Surface soils usually are relatively dry in early spring and warm up quickly with warm days. Cool season grass species will germinate at lower temperatures, provided adequate soil moisture is available.

Seed emergence studies (Wester and Dahl 1983) at Lubbock, Texas, show best emergence of sideoats grama *(Bouteloua curtipendula)* with consecutive days of at least 0.2 in. precipitation and a soil temperature of 86 F. Seedlings under these greenhouse conditions emerged in 2 days. At temperatures of 75 F and 63 F, emergence occurred in 4.2 and 7 days, respectively. No plants germinated at soil temperatures above 100 F even with 0.6 in. of water applied over 3 days. The soil apparently dried too rapidly.

Seedling establishment of blue grama requires two properly spaced periods of damp, cloudy weather - one for emergence and one for development of adventitious roots. These periods of cloudy, wet days need to be spaced about 2 to 6 weeks apart. The seedlings seldom survive longer than 6 weeks without adventitious roots (Wilson and Briske 1979), and they recover from drought-induced stress only if they have developed such roots (Wilson and Briske 1978). The largest number of adventitious roots were initiated at 68 F and two or more consecutive wet days (Briske and Wilson 1977). Adventitious roots are also needed for winter survival of Blue grama.

It may be unrealistic to predict successful seedings with best known cultural methods during years of below normal precipitation. However, climatic data can be used to select the seasons when precipitation probability is the greatest and temperatures are adequate. Evaporation or effective precipitation must also be considered as temperature increases.

Generally, seeding as early in the spring as possible is best, particularly with cool season species (McGinnies 1973). Research at Manhatten and Hays, Kansas indicate that March 15 through May 15 is the best time to seed warm season native grasses (Launchbaugh and Anderson 1963). Better seedling survival was obtained from planting prior to May 1 in southwestern Kansas (Schumacher and Atkins 1965). June and July seeding, not recommended in southeastern Colorado, has shown variable results; however, it may be successful with certain precipitation patterns.

Standards and Specifications

Standards and specifications for seeding CRP lands have generally been developed on a state by state basis. SCS standards and specifications for seeding have been used with modifications to adapt for local needs and for requirements of other agencies such as the Colorado Division of Wildlife and the Agricultural Stabilization and Conservation Service. The SCS Range Seeding and Pasture and Hayland Seeding Standards and Specifications are generally used to regulate most CRP acreage seeding in the Central Plains.

The standards used depend on which practices (CP-1, permanent introduced grasses and legumes; CP-2, permanent native grasses; CP-3, tree planting; CP-4, wildlife habitat; CP-5, field wind break; etc.) are applied. In Colorado and Kansas, CP-2 is the major practice applied, while in Wyoming it is CP-1 and in Nebraska it is dominantly CP-4.

Tables 2, 3 and 4 highlight the main items from SCS State Range Seeding Standards and Specifications.

It is important to use the proper cultivar or strain of plant material. Released cultivars have been selected for improved characteristics. Using the proper cultivar may be just as important as selecting the right species. A brief summary of common varieties used in the Central Plains is provided in table 5.

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Table 2.--Summary of SCS standards and specifications for range seeding, seeding depth, date and rate.

Location	Date	Rate (seeds/ft.)	Depth (in.)
Colorado	Warm season species		
Eastern Plains	Nov 1-May 20 southern Oct 15-May 20 northern	20	1/2-1 (2-3 Indian Ricegrass)
	Cool season species		
	Nov 1-Apr 30		
Kansas	March 15-May 15 (Opt.)	22-25	1/4-3/4
Western Plains	Dec 1-May 15 (Max)		
Wyoming	Warm season species	(Ave 20)	1/2-3/4 (light soils)
(Southeastern)	Early Spring-May 15		
	Cool season species		
	dormant-Apr 15	14-40	1/4-1/2 (heavy soils)
Nebraska	Warm season species		
(Western)	Nov 1-May 31 Mar 15-May 15 (Opt)	20 (min)	1/4-1
	Cool season species		
	Aug 1-Sept 15 and Nov 1-Apr 15		

Table 3.--Summary of standards and specifications for range seeding, cover crops.

Location	Planted cover crop	Residual cover crop
Colorado Eastern Plains	Forage & Grain Sorghum Sudan Broomcorn (18 in. ht.)	Sorghum, Sudan Broomcorn, Millet Wheat (9 mo. old)
Kansas Western Plains	Forage Sorghum Grain Sorghum Small grains (oats, wheat) (12 in. ht.)	Surface mulch essential
Wyoming (Southeastern)	Spring Grain (10 in. PPT +) Sorghums Sudangras Foxtail Millet	Stubble (free of weeds and volunteer)
Nebraska (Western)	Grain Sorghum Forage Sorghums Hybrid Sudangrass (May require 2 or more years) (12 in. ht.)	Sorghum Corn Stubble Millet (Broomcorn) (12 in. ht.)

Table 4.--Summary of SCS standards and specifications for range seeding, weed control, planting methods, row width.

Location	Method	Row width (in.)	Weed control
Colorado Eastern Plains	Drill Interseeder Airseeder	7 - 12 Interseeder < 42	Herbicides Mowed
Kansas Western Plains	Drill Broadcast (BDCT discourages)	------	Herbicides Mowed Graxing (Not CRP)
Wyoming (Southeastern)	Drill or Grass seeder Interseeder	up to 24 Iinterseeder	Herbicides Clippings 4" min. Shred
Nebraska (Western)	Drill Interseeder	------- < 42" row	Herbicides Mowed Shred

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Table 5.--Summary of major grass varieties recommended for central Great Plains.

NATIVE

Species/Cultivar	Recommended CO KS WY NE	Source	Released	Outstanding characteristics
Big Bluestem	*(Andropogan gerardii)*			
Champ	WY NE	NE ARS	1963	Maturity 10 days earlier than Pawnee, sandy soils
Kaw	CO KS NE	KS Ex. Stn.	1950	Flint hills, tall, resist to rust
Pawnee	KS NE	NE	1963	Late maturity - orig Pawnee, Co. NE
Little Bluestem	*(Schizachyrium scoparius)*			
Aldous	KS NE	KS	1966	Orig Flint hills, leafy, some rust resistance
Camper	NE	NE	1973	Breeders selected for Kansas and Nebraska
Cimarron	CO KS WY NE	KS	1979	Assembled from KS, S. E. CO, NM, and OK Panhandle
Pastura	CO WY	NM	1963	Seedling vigor, seed production
Blaze	KS NE	NE	1967	Adapted to central and N.E. NE
Sand Bluestem	*(Andropogan gerardii* var. *hallii)*			
Champ	CO NE			
Elida	CO	NM	1963	Seed production, seedling vigor
Garden	KS WY NE	NE	1960	Winter hardy, vigorous, tall, leafy
Goldstrike	WY NE			
Woodward	CO KS	OK	1955	Seed production, high yields
Blue Grama	*(Bouteloua gracilis)*			
Lovington	CO KS WY NE	NM	1963	Uniform, leafy, seedling vigor
Hachita	CO KS	NM	1980	Vigorous, drought hardy, robust
Sideoats Grama	*(Bouteloua curtipendula)*			
Haskel	CO	TX	1983	Seedling vigor, high yield
Butte	CO WY NE	NE	1958	Winter hardy, northern range, good seedling vigor
El Reno	KS	OK	1944	Leafy high forage and seed yields
Niner	CO	NM	1984	Seedling vigor, tall, high production
Pierre	WY NE	ND		Seedling vigor, leafy
Trailway	NE	NE	1958	Late maturing, rust free
Vaughn	CO WY	NM	1940	Seedling vigor, drought tolerant
Buffalograss	*(Buchloe dactyloides)*			
Texoka	KS		1974	High seed potential
Improved	KS			Available prior to Texoka
Greenneedle	*(Stipa viridula)*			
Lodorm	WY			
Indiangrass	*(Sorghastrum nutans)*			
Cheyenne	CO KS	OK	1954	Good seed and forage yields
Holt	NE	NE	1960	Early maturity, fine leaves
Llano	CO	NM	1963	Leafy, high seed yields

(continued)

Table 5.--*(continued).*

NATIVE

Species/Cultivar	Recommended CO KS WY NE	Source	Released	Outstanding characteristics
Osage	KS	KS, OK	1966	Tall, vigorous, leafy late maturity
Oto	NE	NE, KS	1970	Long season variety, erect robust
Nebraska 54	KS NE	NE	1957	Tall, leafy, high seed yields, good seedling vigor
Prairie Sandreed	*(Calamovilfa longifolia)*			
Goshen	CO KS WY NE	WY	1976	High forage yields, drought hardy, mildly rhizomatous
Sand Lovegrass	*(Eragrostis trichodes)*			
Nebraska 27	CO NE	NE	1949	Winter hardy, palatable
Bend	CO KS	OK, KS	1971	Uniform maturity, good establishment
Prairie Sandreed	*(Calamovilfa longifolia)*			
Goshen	CO KS WY NE	WY	1976	High forage yields, drought hardy, mildly rhizomatous
Sand Lovegrass	*(Eragrostis trichodes)*			
Nebraska 27	CO NE	NE	1949	Winter hardy, palatable
Bend	CO KS	OK, KS	1971	Uniform maturity, good establishment
Switchgrass	*(Panicum virgatum)*			
Blackwell	KS NE	OK	1944	Upland type, leafy, high yielding
Kanlow	KS	OK	1963	Tall, Coarse, productive, low land
Nebraska 28	CO WY NB	NB	1949	Early maturity, susceptible to rust
Pathfinder	NE	NE	1967	Winter hardy, leafy, late maturing, rust resistant
Slender Wheat	*(Agropyron trachycaulum)*			
Revenue	NE	Canada	1970	Salt tolerant, high seed and forage yields
San Luis	CO	CO	1984	Good seedling vigor, longlived, tall, robust
Thickspike Wheatgrass	*(Agropyron dasystachyum)*			
Critana	CO WY	MT	1971	Vigorous sod, drought hardy
Western Wheatgrass	*(Agropyron smithii)*			
Arriba	CO WY	CO	1973	Vigorous seedling, spreader
Barton	CO KS WY NE	KS	1970	Vigorous seedling, spreader
Flintlock	NE			
Rosana	CO W	MT	1972	Palatable, tight sod, seed production
Old World Bluestem	*(Bothriochloa ischaemum/caucasicus)*			
Ganada	CO KS	USSR	1979	Cold tolerant
Iron Master	KS		1987	Doesn't show iron deficiency

(continued)

Table 5.--*(continued).*

NATIVE Species/Cultivar	Recommended CO KS WY NE	Source	Released	Outstanding characteristics
WW Spar	KS		1985	Seedling vigor, increased production
El Kan	KS	KS	1955	Increased seed production
Smooth Brome	*(Bromus inermis)*			
Manchara	CO WY	China	1943	Wide area adaptation, strong sod, cold tolerant
Lincoln	CO WY	NB	1942	Production, establishment
Tall Fescue	*(Festuca arundinacea)*			
Alta	CO KS NE	OR	1940	Winter hardy, high yield
Kenmont	KS NE	KY	1963	High yield, dense sode, adapted in MT
Fawn	KS NE	OR	1964	High protein, seed yield, spring vigor, high yield
Weeping Lovegrass	*(Eragrostis curvula)*			
VNS	KS NE			

(continued)

Table 5.--*(continued).*

NATIVE Species/Cultivar	Recommended CO KS WY NE	Source	Released	Outstanding characteristics
Crested Wheatgrass	*(Agropyron cristatum/desertorum)*			
Ephraim	CO WY	Turkey	1983	Seedling vigor, sod former, seed yield
Nordan	CO WY	ND	1953	Seedling vigor, robust growth
Hycrest	CO WY	USSR	1984	Hybred, seedling vigor, high yielding
Intermediate Wheatgrass	*(Agropyron intermedium)*			
Oahe	CO WY	SD	1961	High seed and forage, rust resistance
Amur	CO	China	1952	High production, leafy, seedling vigor
Pubescent Wheatgrass	*(Agropyron trichophorum)*			
Luna	CO WY	USSR	1963	Drought tolerant, seedling vigor, high yields

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Range Plant Establishment in the Southern Plains Region

Bill E. Dahl, Paul F. Cotter, David B. Wester and Carlton M. Britton[1]

Abstract.--Failure to establish seeded stands is most commonly due to patterns of rainfall, inadequate seedbed preparation, and failure to sufficiently remove competing vegetation. Most frustrating of stand failures are those resulting from enough moisture to germinate seeds but when follow up moisture comes too late for seedling establishment. Soils of the region are especially susceptible to wind erosion, making the preparatory crop method more desirable here than in other regions. These crop residues also reduce soil temperatures, help control weeds, and reduce evaporation - all critically needed in the hot climate of the Southern Plains. Weeping lovegrass, sideoats grama, blue grama, switchgrass and old world bluestems are species most commonly seeded on Southern Plains ranges.

Not since the "Soil Bank" era have we seen as much interest in grass seeds, seed production, wild seed harvest, seeding equipment, and techniques on how to seed semi-arid cropland or eroding land. Of course, this has been triggered by the advent of the Conservation Reserve Program (CRP) contained in the 1985 Farm Bill. Under this program the federal government is essentially "renting" highly erodible cropland for 10 years from farmers and ranchers, and requiring this rented land be planted to permanent vegetation. Already, after only one planting season, seed supplies are nearly exhausted and those wishing to plant are competing for any kind of available seed. Inevitably, much of this land will be seeded to species ill-adapted to the land being seeded.

Regardless of the reason to seed areas to grass, one should ideally plan the initial planting as a long term investment. Some of the questions that should be asked when choosing among potentially available species are given here as a planning guide: Is the species you have chosen adapted to your soil? Is seed available at a reasonable cost? How soon will you need to use it? What is the risk of seeding failure? How long will the seeding last? Will new fences be required? Will water be available for grazing animals? Is wildlife use, (e.g. upland game birds), an important consideration? What are the management requirements? What kind of livestock or wildlife will use it? Is stand establishment technology and the necessary equipment available? Will this seeding benefit your overall goals and objectives? How will this seeding fill existing gaps in your current grazing management scheme? Is irrigation a possibility? Will you want to harvest seed from this stand? Above all, have you sufficiently checked the costs and expected returns to find out if your chosen seeding program has a reasonable chance of returning a profit?

A range revegetation program requires more advance planning than most operators realize. This report is designed to answer some of the common questions relative to revegetating marginal and eroding cropland in West Texas.

Failure to obtain a successful seeded stand is most commonly due to one or more of the following items: (1) lack of rain at the proper time; (2) inadequate seedbed preparation; (3) improper seeding depth; (4) weed competition; (5) seeding at the wrong time of the year; (6) insect and rodent damage; (7) species not adapted; (8) poor quality seed; (9) improper equipment; and (10) lack of grazing protection until stand establishment. Thus, successful seedings depend on the attention devoted to the above items.

Climate and Timing

In the Southern Plains, range seeding is only recommended where annual precipitation averages 11 in. or more. Seeding failures commonly occur from rain of 0.5 in. or less that germinate planted seed but follow-up rain that is needed in 4 or

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5 days comes too late to allow survival of new seedlings. Unfortunately, most rainfall events in semiarid climates below 24 in. of annual precipitation in the Southern Plains are less than 0.4 in. per event. Thus, we suggest planting just prior to the most consistent rainfall period that has favorable temperatures for seed germination.

Most of the Southern Plains has from 12 to 24 in. of annual precipitation. The most consistent rainfall comes during the last 10 days of April through May and again in September and October. Thus, warm season species should be seeded in April and May. Cool season species are seeded in April or, preferably, in August and September. While seedlings of warm season species from June plantings occasionally survive, high temperatures and inconsistent rainfall make this a risky period without availability of irrigation water to insure seedling establishment. Experience has indicated that seedlings from late October plantings seldom survive the winter due to the low probability of receiving sufficient rainfall.

Soils

All plants useful for permanent pasture do well on intermediate soil textures, i.e. sandy loams, silts, and loams. However, few do as well on the clays, clay loams, loamy sands, and sands. Those that grow well on the coarse textured soils cannot tolerate clay soils and vice-versa. Other soil conditions requiring careful species selection are high salinity, alkalinity, and high water tables that preclude adequate soil aeration.

The following discussion gives results of our testing of those species thought most useful for seeding west Texas croplands to permanent forage. Seven high yielding grasses were evaluated on the High Plains of Texas on three soils of varying texture. Grasses tested were Blackwell switchgrass *(Panicum virgatum)*, El Reno sideoats grama *(Bouteloua curtipendula)*, Morpa weeping lovegrass *(Eragrostis curvula)*, and four old world bluestems (*Andropogon* spp.) which included Caucasian, WW spar, Ganada, and WW517. Row spacing width was 40 in. and seeding rate was 65 pure live seed per ft. The soils were an Acuff loam (clay loam range site) at Lubbock, an Amarillo loamy fine sand (sandy land range site) at Brownfield, and a Brownfield fine sand (deep sand range site) near Post, Texas. Brownfield and Post are located about 35 mi. southwest and southeast of Lubbock, respectively.

Establishment of all species was highest at the sandy land range site near Brownfield. It had an average within-row basal cover of 55%. Basal cover at Lubbock and Post was 49% and 18%, respectively. Switchgrass, sideoats grama, and weeping lovegrass were the easiest to establish during a year with good soil moisture. However, all species provided acceptable stands. During a year with less favorable precipitation, switchgrass and sideoats were easiest to establish.

The highest yields were at Lubbock, probably due to a substantially higher soil nitrogen level. All species yielded about 8,000 lb./acre except sideoats grama and Ganada old world bluestem. They produced about 5,000 lb/acre during favorable conditions. In a dry year, switchgrass and WW517 produced twice the yield of the other species. At Brownfield, similar trends were evident except the yields were less than half those measured at Lubbock. Yields at Post were lowest of the three areas with weeping lovegrass the only species producing appreciable forage on this deep sand site.

Considering all factors, including response to fertilization and defoliation, weeping lovegrass yielded best on the sandier soils and WW517 performed best on the heavier soils. Switchgrass could be used to extend the green feed period longer into the summer months.

Planting Methods

Bare soil can be vegetated by sprigging (vegetative transplants) or seeding (broadcasting or drilling seed). Sprigging is commonly used only where sufficient natural rainfall occurs to give a reasonable chance for plant survival. Even then, it is usually limited to sandy soils. Sprigging has not been shown to have any advantage over traditional seeding techniques on central and west Texas ranges.

For seeding bare soil areas, drilling is preferred to broadcasting on terrain suitable for the operation of machinery. Drilling distributes the seed more uniformly and places it at a proper depth. A few companies manufacture drills specifically to handle the array of small, fluffy seeds of range grasses adapted to the west Texas area. Ordinary grain drills with small seed boxes in good repair will handle some of the small, clean seeds, but depth control is often a problem on such drills. Desirable characteristics of rangeland drills are:

1. Ability to traverse rocks and brush with minimum breakage;
2. Separate seed boxes for small, large, and fluffy (trashy) seeds;
3. Agitator in the seedbox to prevent trash bridging over the seeder openings;
4. Precise metering of seed;
5. Seedbox baffles to maintain seed distribution in the box;
6. Disk openers with band-type depth regulators;
7. Flexible individual planters to adjust to irregular seedbed; and
8. A mechanism for rapid and accurate setting of seeding rates.

On areas with well prepared seedbeds, the grass seeder-packer is a type of drill without furrow openers that provides excellent grass stands. These planters consist of a seeder box mounted over one or more cultipackers that pack the soil about 0.5 in. deep over the seed. Others have also been called "till-and-

pack" drills. This method of planting has been the most consistently successful method of grass establishment in the semidesert grasslands of the Southern Plains when preceded by a pitting operation to conserve soil water.

Any method that scatters seed directly on the soil surface without soil coverage is termed broadcasting. Two types of equipment are commonly used; hydroseeders which apply the seed mixed in water, and fan or air blast seeders. Airplane seeding and hand seeding are also common ways to do broadcast seeding. The seed, however spread, must be covered with soil in some way if it is to become established after germination. This is especially true in desert areas, in arid foothills soils, or on unfavorable sites such as south and west facing slopes at higher elevations. In all cases, broadcast seed covered with soil is much superior to no coverage of seed, especially on sites with rough, cloddy surfaces.

Seed can be covered with harrows, discs, home-made drags, or small sheeps-foot rollers. Running a small tracked vehicle over the area after seeding also may cover the seed satisfactorily. For small areas, driving a tractor over the area such that all portions of the seeded area are disturbed by its tracks is an excellent way to cover the seed as well as provide desirable soil compaction around the seed.

Seedbed Preparation

Several methods of seedbed preparation have been successfully used in range seeding. They are: (1) mechanical methods; including clean tillage and summer fallow; (2) preparatory crop method; and (3) herbicidal methods.

Mechanical Seedbed Preparation

Equipment commonly used for seedbed preparation on rangeland include: disk turning plows; moldboard plows; pitters; modified chains (disk chain, dixie chain, railroad chain); disk plow; wheatland disk plow; brushland disk plow; and offset disk. Most of these create weed-free seedbeds that can result in severe erosion on the sandier soils. Wind erosion not only blows out seed and seedlings in some spots and buries it in others, but it can also shear off young plants by sandblasting. Blowing soil is less of a problem on the more clayey soils.

A major problem in mechanical seedbed preparation has been loose, soft soil that interferes with proper placement of seed and has poor water-holding capacity. Firm seedbeds hold moisture near the surface, help control depth of seeding, and provide anchorage for seedling roots. Rolling before drilling usually improves seed placement and gives better seedling emergence. However, rolling after drilling is generally detrimental. Also, seedbeds compacted and smoothed by rolling are more subject to wind and water erosion.

Small diameter rollers often skid rather than roll, thereby increasing soil density and possibly reducing water intake. Flexible cultipackers are better able to adapt to uneven terrain than flat rollers, give greater packing action below the seed placement zone, and leave a soil surface more suitable for seeding. Drag harrows and rod weeders are also useful for smoothing and compacting where surface trash is not excessive.

Rolling and cultipacking are only successful when existing soil moisture is sufficient for germination and seedling emergence. This is seldom possible in the semi-arid Southern Plains because surface drying is too rapid to allow moisture retention. Whether to use rolling or cultipacking should be decided at the time of seeding based on the conditions of the seedbed. On medium to fine textured soils in the arid portions of the Southern Plains (i.e., less than 12 in. of annual rainfall), seedbed preparation should include pits, basins, or interrupted furrows to catch and hold moisture as an effective technique for achieving good stands. Eccentric disks and other types of pitting machines have been successfully used. Seedings made in the basins have the advantage of extra soil water for germination and establishment. Such practices are usually ineffective on sandy soils.

Preparatory Crop Method

The preparatory crop method involves plowing followed by planting a residue-producing crop during the growing season before seeding perennial forages, and then seeding directly into the residue without further seedbed preparation. Prevention of erosion, reduction of soil temperatures, control of weeds, and reduced evaporation are potential benefits achieved from preparatory cropping. Crops most commonly used for this purpose are sudangrass, other sorghums, and millet.

Winter cereal crops have generally not been as useful as the sorghums. However, winter wheat is a common cover crop for seeding in Oklahoma where old world bluestems are to be planted. The wheat is either grazed out or killed with herbicide the following spring before it can utilize moisture prior to seeding. This technique has also been commonly recommended for weeping lovegrass establishment in the Lubbock area.

Success of the preparatory crop method depends largely on the degree of weed control achieved during the growing of the crop. In one study in which forage sorghum was the preparatory crop, sandburs (*Cenchrus* sp.) were not successfully controlled. Seeding into the sorghum stubble the next year was totally unsuccessful because of intense competition from the sandburs. Other seedbed techniques which controlled the sandburs provided successful stand establishment for the desired species.

Chemical Seedbed Preparation

Chemical seedbed preparation and direct seeding into the killed mulch without further soil treatment is effective if the herbicide, (1) controls a broad spectrum of undesirable plants, (2) dissipates rapidly after weed control is accomplished, and (3) is broken down or leached away by the time seeded species germinate or is not toxic to seedlings. Despite the obvious

advantages of chemical weed control in preparing seedbeds, results are often disappointing because of ineffective control of the existing vegetation. No single chemical is yet available which completely kills all resident plants and also dissipates rapidly afterward.

Herbicides[2] used with varying degrees of success on rangeland plantings are paraquat, glyphosate, dalapon, atrazine, propazine, amino triazole, disodium methanearsonate (DSMA), and siduron and picloram in combination. These include both preemergence and postemergence herbicides.

Fertilization

Fertilizing to aid stand establishment at time of seeding is a hotly contested subject. Most researchers working in semi-arid to arid climates find that adding fertilizer at seeding time usually enhances weed growth, and consequently, competition with the seeded species. If fertilizer is deemed necessary, it is usually better to wait until the seeded species have at least one growing season to become established.

Seeding Rates

The seeding operation should provide adequate seed for a good stand while preventing waste of seed. Increased rates of seeding are suggested for poor seedbeds. When broadcasting, more seed should be used; the usual recommendation is twice the drilling rate. Low seeding rates usually require longer periods of protection for complete stand development, whereas moderate rates are best to produce a full stand within a reasonable time. Range seedings are now commonly done in the Southern Plains on the basis of number of pure live seeds (PLS) per square foot. Seeding rates based on 30 pure live seeds per square foot have become standard for seeding grasses on upland range sites.

Seeding rates may be increased on sites having high production potential. Seeding rates should be adjusted for individual species and seedbed conditions where research and local experience have shown this to be desirable. The quantity of seed should be increased by 50 to 100% on more critical sites such as west and south slopes. Seeding rates are also commonly increased 50 to 100% on more productive bottomland or irrigated sites. If one desires to seed with rows wide enough to allow for cultivation (e.g. 24 to 40-in. rows), 20 to 30 PLS per foot of row should provide an adequate stand.

Planting Depth

The ideal seeding depth for grass seeds is about 1/4 in. for small seed such as lovegrasses, 1/2 in. for average sized seed such as pubescent wheatgrass *(Agropyron trichophorum)*, and 1 in. for very large seeds such as tall wheatgrass *(A. elongatum)* Since all species potentially useful in west Texas are small seeded, seeding depths should be no greater than 1/2 in. Depth bands on disc opener drills are commonly 5/8 to 3/4 in., which places seeds about 1/4 to 3/4 in. deep.

Row Width

Row widths of 10 to 14 in. are most commonly used in range seedings. However, numerous research reports indicate that total herbage production in the Southern Plains is not generally affected by row widths between 6 and 18 in. after full establishment.

Trends of higher yields with narrow spacing immediately after establishment to no difference or higher yields from wider spacing in later years have been reported. Rows spaced 40 inches apart to allow for cultivation have yielded as much forage as more closely spaced rows. However, such spacing tends to increase the proportion of reproductive shoots which some find objectionable for grazing purposes. The advantage is obvious to those interested in raising grass seed.

Germination Requirements

Our research shows that many species used for west Texas plantings require two applications of water for seed germination and seedling emergence. Weeping lovegrass, kleingrass *(Panicum coloratum)*, and possibly the old world bluestems are examples. An inch or more of rain germinated only a few seeds in some of our field plantings if follow-up rain was delayed more than 4 or 5 days. However, as little as 0.2 in. per day for two days would germinate almost all seeds.

Apparently, many seeds imbibe enough water to start the germination process but because of rapid soil surface drying, they do not retain enough to fully germinate the seed. If a second wetting of at least 0.2 in. occur within 3 or 4 days, the seeds will germinate and emerge as a seedling. If the second rainfall event does not occur within the four or five days, these seeds will again require two applications of water for germination.

Once the seedlings emerge, there must be sufficient soil water in the rooting zone to allow for seedling survival. Seedlings usually die within 5 or 6 days in the Southern Plains once the soil has dried. Seedling survival, will also occur if there is sufficient water to wet the soil several inches deep in the rainfall events that provided for germination. Otherwise, a followup rainfall event must occur within 4 or 5 days after seedling emergence. With this kind of information, we are better able to judge whether our planted seeds have mostly germinated and died, or whether the rainfall events have been too far apart to fully germinate the seeds.

[2]The use of trade company names is for the benefit of the reader; such use does not constitute an official endorsement or approval of any service or product by the U.S. Department of Agriculture to the exclusion of others that may be suitable.

Stand Establishment With Irrigation

Many west Texas farmers still have the ability to irrigate part or all of the land they intend to plant to permanent forage. As described above, enough rainfall to germinate seeds is commonly received, but followup rain comes too late for seedling survival. Therefore, having the means to assure adequate soil water at these critical times can often mean the difference between stand establishment or failure.

A suggested scenario for someone with irrigation potential is to dry plant on a well prepared, weed free seedbed, then wait for natural rainfall of at least 0.25 inch. When it is possible to irrigate, preferably the day after natural rainfall, begin applying a moderate amount of water, e.g., 1-inch. This both provides the second watering required to fully germinate planted seeds and it assures enough soil moisture for seedling survival. Unless the summer is unusually dry, natural rainfall should keep the seedlings alive once they are established. Amounts of water applied should be greater than a comparable natural rainfall event due to higher and more rapid evaporation. Unless natural rainfall provides one watering, two irrigations will be required for seedling establishment. The two waterings should not be more than 4 days apart. A large field may have to be seeded in segments if it is not possible to irrigate it all in 4 days.

What is an Acceptable Stand?

For range seedings, we like to have at least one established seedling per square foot or per foot of row if rows are spaced more than 1 ft. apart. Realistically, a successful planting can occur with much less than that. Uniformity is more important than plant density. In the Southern Plains, one established perennial plant per square yard will eventually produce all of the forage most sites are capable of producing. Therefore, if one or more seedlings can be found for every step when walking through a seeding, a successful stand should result.

Buying Seed

Range grass seed is typically trashy and fluffy with only a small fraction of actual seed in the material put through the planter. Because the amount of actual seed varies widely among seed lots of the same species, seeds are sold on a PLS basis. This means that every seed lot has to be tested for purity. By law, seed labels are required to give the amount of pure seed, seed germinability, the amount of other seed, date of the germination test, and where the seed was grown. For example, if a lot of seed is 80% pure seed and the germination is 50%, then for every 100 lb. of bulk material you get, you have 80 lb. of seed (designated PS). Since it is 50% viable you have 40 lb. of pure live seed (designated PLS). Percent purity multiplied by percent germination gives PLS. It is also preferable that the origin of the seed is local enough to be adapted to the particular climate where it is planted.

Weed Control During Establishment

In semi-arid and arid climates of the Southern Plains, weed prevention is more important than weed control after seedling emergence. Grassy weeds, e.g. sandburs, Japanese brome *(Bromus japonicus)*, and foxtail grasses (*Setaria* spp.) are particularly difficult to control in grass plantings. Most herbicides that kill the grassy weeds also kill the seedlings. We find that a cleanly tilled crop stubble (preparatory crop or dead litter mulch method) gives a relatively weed-free seedbed. Also, early fall seedbed preparation for small grains often gives excellent weed control as germinating weed seeds do not overwinter or do not compete well with the small grain crop.

For newly prepared, clean tilled seedbeds, moldboard plowing produces much better weed control than tandem discing. The top soil and weed seeds are buried by plowing and nutrients are brought to the surface resulting in more vigorous seedlings. Discing mixes the weed seeds and the organic matter in the soil surface without burying it. With discing, decaying organic matter also ties up many of the nutrients needed by the planted seeds. Because discing is much cheaper than plowing, we have found that discing early in the spring, waiting for sufficient rainfall to germinate the weed seeds, then lightly rediscing before planting, provides satisfactory weed control. Any of the contact herbicides may be used in place of the second discing. Broadleaf weed herbicides[3], such as 2,4-D and Banvel, can be used on most grass seedlings after they have 4 or 5 leaves. Recommended dosages should be followed, with application taking place before the weeds become very large.

Erosion Control

Much of the western Southern Plains has soils subject to severe wind erosion. The preparatory crop method, described earlier, constitutes the best means to reduce erosion during stand establishment. When this is not feasible, unplowed strips should be placed perpendicularly to the prevailing wind, especially on highly erodible sandy soils. The main criterion in controlling wind erosion is to prevent the wind from accelerating near the ground across a large unprotected plowed field, a process known as avalanching. To prevent this, relatively narrow strips of vegetation (which may be weeds) should be left while the seeded portion of the field is becoming established. Unplowed strips of 10-20 ft. interspersed with 30-50 ft. plowed and planted strips provide some wind protection. Given favorable weather, one should then be able to plow and plant the windbreak strips the following year.

Establishment of Shrubs and Forbs in the Southern Plains Region

Darrell N. Ueckert[1]

Abstract.--Establishing palatable shrubs and/or forbs in mixtures with grasses is ecologically sound and can improve the value of revegetated areas for wildlife and livestock. Shrubs and forbs that appear to have the greatest potential in the Southern Plains include fourwing saltbush, littleleaf leadtree, winterfat, Maximillian sunflower, and Illinois bundleflower.

The value of shrubs as a plant resource is widely recognized (Blaisdell and Holmgren 1984, Hyder 1973, McKell 1975, Tiedemann et al. 1984, Scifres et al. 1985). There is currently worldwide interest in the use of shrubs for (1) improving the productivity of arid and semiarid rangeland and marginal cropland, (2) alternative crops and emergency drought forage, (3) soil and water conservation, and (4) wildlife habitat improvement. Range scientists and resource managers in the western United States have used shrubs for improving the quality of livestock diets and rangeland productivity (Gade and Provenza 1986). Recent research suggests that several species of shrubs have potential for use in the Southern Plains region (Ueckert 1985). Following is a discussion of three such species.

FOURWING SALTBUSH

Fourwing saltbush *(Atriplex canescens)* has the greatest potential for use on Conservation Reserve Program (CRP) lands in the Southern Plains. The species has been recognized as valuable for rangeland livestock and wildlife for many years because of its abundance, wide area of adaptation, evergreen habit, palatability, and nutritive value (USDA Forest Service 1937). It is salt tolerant and very drought tolerant, often thriving in arid regions having less than 10 in. annual precipitation. Fourwing saltbush has a deep tap root and an extensive, shallow, fibrous root system. It occurs naturally from the Central Plains westward into California, and from northern Mexico to southern Canada. Potential of the species as a cultivated crop was recognized by the beginning of this century.

Fourwing saltbush has substantial growth potential in semiarid areas of the Southern Plains. For example, total standing crop in a west Texas site receiving 15 in. annual precipitation averaged 15,000 lb./ac. within 16 months after seeding (McFarland et al. 1987). The estimated net annual production of 2.5-year old fourwing saltbush plants growing under cultivation on 6 ft. spacings in rows 6 ft. apart near San Angelo, Texas, averaged about 6,000 lb./ac. (Petersen et al. 1987).

Value of Fourwing Saltbush for Grazing

Fourwing saltbush is relatively palatable and maintains high levels of crude protein throughout the year (Soltero and Fierro 1980). It is particularly valuable as browse during the winter for both livestock and wildlife (Springfield 1970). For example, average mid-December values for crude protein, phosphorus, and in-vitro digestible organic matter for the saltbush leaves in one study were 17.9%, 0.14%, and 59%, respectively (Petersen et al. 1987). Winter crude protein does vary, however, among some accessions or ecotypes of fourwing saltbush because of differential retention of winter leaves (Welch and Monsen 1981).

Fourwing saltbush is an important component of livestock diets where the shrubs are abundant (Shoop et al. 1985). Livestock grazing rangelands where fourwing saltbush is abundant have been shown to require very little supplemental feed (Gonzales 1972). In western Texas, an acre of fourwing saltbush might provide the supplemental crude protein requirements for about one animal unit of livestock for a three-month period (Peterson et al. 1987).

Fourwing saltbush alone, or in mixtures with grasses, can provide diets of sufficient quality to produce weight gains of yearling sheep and yearling Angora goats during winter. In southwestern Texas yearling Rambouillet ewes gained about 10 lb./head grazing a fourwing saltbush-sideoats grama *(Bouteloua curtipendula)* mixture, compared to losing 3 lb./head grazing

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dormant WW-Spar bluestem *(Bothriochloa ischaemum)*, during a 60-day grazing trial in 1987. However, data from a spring feeding trial and an autumn grazing trial suggest that fourwing saltbush browse has a lower nutritional value for young Angora goats than would be expected based on laboratory nutrient analyses (Huston and Ueckert 1986).

Fourwing saltbush plants are not harmed by severe defoliation during the winter. In Texas, stands grazed to near 100% defoliation during winter with sheep and goats for several successive years still provided vigorous spring regrowth in early March and were completely refoliated by June. Defoliation during winter followed by deferment in spring and early summer appears to actually stimulate browse production. Saltbush stands should always be deferred during the spring and early summer following heavy winter grazing.

Establishing Fourwing Saltbush

Seeding

Establishing fourwing saltbush by seeding in arid and semiarid areas has been erratic (Leckenby and Toweill 1983). Major constraints include: (1) poor seed quality (poor fruit fill, low germinability, and resultant low seedling vigor) and inadequate seed quantity; (2) inadequate soil water contents at the seed-soil interface during periods of optimal temperatures for germination; (3) effects of interspecific competition on seedling survival, establishment, and growth; and (4) grazing of the seedlings by wildlife, livestock, or insects.

Adequate soil water during periods when temperatures are optimal for seed germination are essential for establishing stands of fourwing saltbush (Springfield 1970). In western Texas, it is better to seed during late summer and autumn than during spring. Saltbush seed must be in close contact with moist soil for 7 to 14 days for germination and emergence, hence multiple rainfall events are usually necessary for seedling establishment.

Methods of seeding fourwing saltbush and modifying the seedbed for water conservation have been thoroughly researched and reviewed (Stevens and Van Epps 1984). It is critical that the germplasm in seeds purchased for planting be adapted to the area to be planted (Petersen et al. 1987). Seeds should be planted at a depth of 0.5 to 1.0 in. in firm, well-prepared seedbeds. Seeding rates as low as 2 lb. per acre are adequate if a drill with double disk openers and depth bands is used. Seeding rates should be greater (4 - 8 lb./ac.) if seedbed preparation is less than optimal or if the seed is broadcast and covered by cultipacking.

Rows of fourwing saltbush should be at least 10 ft. apart for monocultures. About 100 $ft.^2$ per mature plant is an ideal spacing in areas receiving 15 to 20 in. annual precipitation.

Contour furrowing, mulching, pitting, and basins or catchments improve emergence and establishment of seeded shrubs in more arid parts of the Southern Plains (Springfield 1970). However, mulching did not improve establishment or yields of seeded fourwing saltbush in a semi-arid area of western Texas (McFarland et al. 1987).

Drilling fourwing saltbush seed in the bottom of furrows is not recommended because rainfall moves soil downward from the slopes of the furrows and results in excessive seeding depths. Seedling emergence was 4 to 10 times greater following drilling on firm, flat seedbeds compared to drilling in the bottoms of furrows in two experiments in western Texas (D. N. Ueckert, unpublished data).

Transplanting

Transplanting of container-grown fourwing saltbush seedlings is the surest way to attain a successful stand of the shrubs and rapid development of vigorous plants (Petersen et al. 1986). Seedlings can easily be grown in a greenhouse in small containers and are available commercially. Seedlings should be about 6 months old before being transplanted. They should be planted into a well-prepared seedbed that is moist to a depth of at least 1 ft.

Transplanting is much more expensive than seeding, hence it is likely to be an acceptable alternative only for producers who want only a few rows or clumps of shrubs, such as for upland game habitat improvement. Transplanting may also be a means for establishing a few fourwing saltbush plants for seed production and subsequent natural regeneration. Transplanted shrubs begin producing seeds during their second or third growing season in western Texas.

Weed Control

Many fourwing saltbush seedings that have been properly installed have failed to establish because of severe competition from forbs and grasses (Petersen et al. 1986, Van Epps and McKell 1983).

Herbicides have been used to a limited extent for weed and grass control in fourwing saltbush seed orchards, but shrub responses and herbicide efficacy were not reported (Noller et al. 1984). Established stands of fourwing saltbush have not been damaged by broadcast sprays of clopyralid[2] applied at rates that kill susceptible woody plants (Jacoby et al. 1981). Three-month-old, greenhouse-grown seedlings were tolerant of pre-plant soil applications of trifuluralin and oryzalin; however, they were killed by atrazine (Petersen and Ueckert, unpublished data).

Cultivation might be a viable alternative for weed control in shrub plantings on CRP acreage. Cultivation would be possible if the saltbush is planted in rows at least 10 ft. apart, or in single rows 3 - 4 ft. from the closest grass rows. Cultivation may not be feasible for several months after planting because the saltbush

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seedlings normally emerge and grow more slowly than the associated forbs and grasses and the saltbush rows may not be discernible. Weed control is usually not necessary after the shrubs are 1 1/2 to 2 ft. tall.

Grass - Shrub Mixtures vs. Monocultures

Fourwing saltbush may be successfully established by planting the seed in mixtures with various grasses. However, the shrubs develop very slowly and many die because of the competition. Therefore, if rapid establishment and production of vigorous fourwing saltbush stands is the objective, grass - saltbush mixtures should not be planted within a drill row. The best procedure is to plant alternating strips of saltbush and grass. Grasses should not be planted within 3 - 4 ft. of the closest row of saltbush. Width of grass and saltbush strips can be adjusted to satisfy the producer's objectives and to be compatible with available planting equipment. It is important to know that fourwing saltbush seedlings initially grow very slowly and that they are easily killed by competing vegetation (Peterson et al. 1986).

LITTLELEAF LEADTREE

Littleleaf leadtree *(Leucaena retusa)* is a deciduous legume with characteristics similar to the closely related koa haole *(L. leucocephala)*, a widely used forage plant in the tropics. The plant can grow to a height of 15 ft., or be maintained in a shrubby growth form by frequent browsing or pruning. It is readily browsed by livestock and wildlife (Lamb 1975). The species is endemic to dry, well-drained, rocky soils in central and western Texas and in Coahuila, Mexico and is fairly drought tolerant.

Littleleaf leadtree will shed some of its leaves during extended hot, dry periods, but the plants produce new flushes of foliage with each significant rainfall event during the growing season. The species is relatively rare on rangelands because of its high palatability and low competitive ability of the seedlings.

The species loses its leaves after frost, but it appears promising for providing high quality forage during dry summer and early autumn periods. Littleleaf leadtree should be considered for use only in the more southerly areas of the Southern Plains since its ability to tolerate low temperatures has not been documented.

Value of Littleleaf Leadtree for Grazing

The forage of littleleaf leadtree is similar in quality to alfalfa hay. Crude protein contents of the forage averaged 21% and in-vitro digestible organic matter averaged about 67% during May through November (Whisenant et al. 1985). Yearling Rambouillet ewes grazing monocultures of littleleaf leadtree during the autumn gained 0.23 lb./head/day in one unpublished western Texas study. There is evidence that good stands of littleleaf leadtree might produce adequate forage to carry 10 to 13 lambs/ac. for 30-day, intensive grazing periods.

Unlike koa haole leaves, which contain up to 12% mimosine, a toxic amino acid, leaves of littleleaf leadtree contain only about 1-2% mimosine. No clinical or pathological signs of mimosine toxicity have been observed in Angora billy kids or Rambouillet ewe lambs grazing pure diets of littleleaf leadtree for 30- to 34-day periods.

Establishing and Managing Littleleaf Leadtree

Intensive management may be essential to successfully establish littleleaf leadtree from seed or containerized seedlings. The seedlings die readily or become severely stunted if competing forbs and grasses are not controlled. Seedlings are also very susceptible to being killed by insects and rabbits. Its seeds have an impervious seed coat that must be scarified for optimal germination. Untreated seeds exhibited only 6% germination compared to greater than 90% germination for seeds that had been effectively scarified in boiling water for 10 seconds or concentrated sulfuric acid for 20 to 30 minutes. It has been recommended that unscarified seeds be planted in the autumn or that scarified seeds, or a mixture of scarified and unscarified seeds, be planted in the spring (Whisenant et al. 1985). Littleleaf leadtree seeds should be planted about 1 in. deep in well-prepared seedbeds. Rows of littleleaf leadtree should be spaced about 8 to 10 ft. apart. Seeding rate should be adequate to establish at least one plant per 3 ft. of row. Close spacing of plants should aid in encouraging the shrub growth form.

The plants exhibit very rapid growth after establishment and should be either grazed heavily or pruned to a 2-feet height each winter to maintain them in the shrub growth form for optimal availability of browse for grazing. The plants will usually have a single-stemmed growth form until they have been pruned back. Pruning stimulates basal sprouting from dormant buds along the lower stems.

WINTERFAT

Winterfat *(Ceratoides lanata)* is a low-growing evergreen shrub that is endemic from northern Mexico to Canada and from the western Great Plains westward to California. It is widely recognized for furnishing palatable and nutritious browse for both livestock and big game animals (Blaisdell and Holmgren 1984).

Winterfat is high in crude protein during winter months (Davis 1979), and utilization as great as 80% during this time does not adversely affect its vigor (Hodgkinson 1975). Utilization greater than 25% in the growing season does diminish vigor of the shrubs, however (Stevens et al. 1977).

Winterfat is adapted to a wide array of soil types, but is most common on calcareous, limey soils. It is highly drought tolerant, with a deep tap root and shallow, fibrous root system. It domi-

nates extensive rangeland areas where annual precipitation is less than 10 in., and extends into subalpine areas where annual precipitation is as great as 40 in. (Stevens et al. 1977).

Seeds of winterfat are commercially available. The seeds lose viability within 2 or 3 years after harvest, so seed should not be stored for longer than 2 years. Seeds should be planted at a depth of 0.1 to 0.5 in. in very firm, well-prepared seedbeds shortly prior to the period during the growing season with highest probability of rainfall (Wasser 1982). Winterfat seed should be planted in separate rows from grasses. Survival and growth of winterfat seedlings are greatly reduced in the presence of competing vegetation (Van Epps and McKell 1983).

PERENNIAL FORBS

Several other perennial plants that are not shrubs have characteristics desirable for use on CRP acreage. Maximillian sunflower *(Helianthus maximiliani)* is a native, perennial forb that grows to a height of 3 to 9 ft. It is best adapted to depressions or other areas that are seasonally moist in the more southerly areas receiving at least 19 in. of annual precipitation. The seeds are choice food for quail and dove, and the forage is palatable to deer and cattle. Seed should be planted 0.25 to 0.5 in. deep during the spring.

Illinois bundleflower *(Desmanthus illinoensis)* is a warm-season, perennial legume with woody lower stems. It is adapted to upland and bottomland sites with clay soils in areas receiving over 15 in. of annual precipitation. The species occurs naturally from central Texas northward well into the Central and Northern Plains. Illinois bundleflower seeds are excellent food for quail, dove, and turkey, and deer readily browse the plants. Seeds should be planted 0.5 to 0.75 in. deep during spring.

CONCLUSION

Establishing shrubs and desirable forbs on converted cropland in the CRP could provide potentially valuable wildlife habitat during and subsequent to the 10-year program, as well as a valuable grazing resource for livestock after it ends. Establishment of shrub or forb plantings or mixtures of shrubs, forbs, and grasses on CRP acreage would appear to be a desirable option for producers whose long-term objective is to permanently convert a portion of their cropland into wildland, wildlife habitat, or grazing land. Planting woody shrubs would obviously not be a viable alternative to those who would likely return the land to crop production after ten years.

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Social and Economic Impacts of the Conservation Reserve Program

E. T. Bartlett[1]

Abstract.--Approximately 23 million acres have been enrolled in CRP during 1986 and 1987. The average accepted bid of $48 per acre will require more than $1 billion in federal funds annually for rental payments. These payments have positive economic impacts for local communities, but other impacts are negative. There are many uncertainties about economic and social impacts and about the future of CRP itself. Like many government programs, the actual results may be far from the intended results. If problems can be detected early, mid-course corrections may facilitate desired outcomes.

The CRP Program

Title XII of the Food Security Act of 1985 initiated several conservation policies and programs including Sodbuster (Subtitle B), Swampbuster (Subtitle C), and the Conservation Reserve Program (CRP) (Subtitle D). Conservation benefits from the CRP include a reduction in erosion and sedimentation, improvement in water quality, and improvement in wildlife habitat. Other projected benefits are a reduction in commodity production, and, thereby, a reduction of ongoing commodity programs and an increase in commodity prices.

Land owners who enroll in CRP enter a ten-year contract with the government to convert highly erodible cropland to permanent vegetative cover. The government will make annual rental payments, in cash or commodities, for the life of the contract; will cover half of the expense to establish permanent cover; and will provide technical assistance. The annual rental payment per acre is determined by a bid submitted by the land owner, which may be accepted or rejected by the government. The total goal for CRP is to enroll 45 million acres of highly erodible cropland over a five-year period. Land under contract may not be harvested or grazed, although fee hunting is permitted.

There are nine acceptable practices under CRP which include (1) establishment of introduced grasses and legumes, (2) establishment of native species, (3) tree planting, (4) establishment of permanent wildlife habitat, (5) field windbreak establishment, (6) diversions, (7) erosion control structures, (8) grass waterways, and (9) shallow areas for wildlife. The majority of land presently in the program will be planted to introduced or native grasses and legumes, cover species for wildlife habitat, and trees (except Christmas trees are prohibited). Most bids that have included tree planting have been in southern states. Proposals accepted into CRP have included 1.25 million acres for tree planting.

In the first two years of the program, almost 23 million acres nationally have been accepted in the five sign-up periods, which is more than 50% of the 5-year goal (table 1). Accepted bids went as high as $90 per acre while the average rental rate was $48.40 per acre. Over one-half of this acreage is in the Great Plains (Colorado, Kansas, Montana, Nebraska, North Dakota, Oklahoma, South Dakota and Texas), with Texas leading the nation with 2.8 million acres. Enrollment in CRP has declined in Colorado during the last two sign-up periods, possibly due to maximum allowable acreages being reached in several southeastern counties.

Economic Impacts and Concerns

Economics has had an influence on the CRP from the beginning. Low commodity prices and costs of other USDA programs were major reasons for CRP. From the start, farmers and ranchers have been concerned with estimating bids that would at least break even with alternative uses of the land. Factors that influenced the bid amount were the cost of establishing permanent cover, cost sharing with USDA, the value of crops formerly grown on the land, and the payments from participation in other agricultural programs. Establishment costs included expenses associated with establishing a cover crop, seedbed preparation, seed and planting, weed control, and maintenance.

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Table 1.--Conservation Reserve Program acreages and average bids for Colorado and the United States through 1987.

Sign up period	Colorado		United States	
	Acres (1,000's)	Aver. bid ($/ac)	Acres (1,000's)	Aver. bid ($/ac)
1	97.67	35.55	838.36	41.82
2	496.42	38.85	3,000.68	40.07
3	467.76	40.69	5,091.62	46.94
4	360.71	43.16	10,572.40	51.17
5	188.91	43.06	5,288.69	47.90
Total	1,611.47	40.60	22,996.00[1]	48.40

[1]Sign up total does not equal the sum of the individual sign-ups as sign-up acreages were taken from initial sign-up summaries which may have had errors and which did not exclude accepted bids that were not contracted. Total came from summary information after the fifth sign-up.

Cost-sharing for permanent cover establishment is limited to those costs incurred in the establishment of permanent cover and does not include annual maintenance costs. Minimum standards and acceptable practices are determined by a committee within each state. The original goal for 1986 and 1987 sign-ups of 15 million acres was exceeded by 8 million acres. Because seed reserves were limited at the start of CRP, annual seed harvest has been the major source of seed for the program. Seed demands have increased seed prices dramatically. Original bids that were based on imperfect knowledge of future seed prices may have been low in many cases.

There are numerous opinions on the economic impacts that the program will have over its 15-year life and beyond. A positive impact within any community is the initial expenditure for establishing permanent cover on CRP lands. For example, if an average cost of $50 per acre for cover establishment is assumed, over $80 million will be spent in the initial establishment efforts in Colorado. Also important will be the annual rental payments to farmers and ranchers. Rental payments in Colorado, paid over a 10-year period, will be $650 million on 1.6 million acres. Total annual payments for land already accepted into CRP will exceed $1 billion nationally.

The $48 per acre average annual rental is a net return to the individual, which may exceed the net realized from cropping highly erodible lands. Also, the bid rental is a constant amount for 10 years, while returns from crops are highly variable, depending largely on weather and market prices. The resultant incentive for enrollment of considerable acreage has had an impact on land prices. In Baca County, Colorado, rental under CRP for summer-fallow wheat land was almost 3 times cash rent, and for row-crop land 1.5 times cash rent (Reichenberger 1987). Thus, a market has been created for highly erodible land that is presently enrolled in or eligible for CRP. In some cases, the high rental rates under CRP have resulted in higher land prices.

A significant negative impact will be the reduced sales by agribusinesses as farmers' needs for chemicals, equipment, fuels and other items used in crop production decline. To minimize this impact, not more than 25% of the cropland in a county can be enrolled in CRP "except that the Secretary may exceed the limitation established ... in a county to the extent that the Secretary determines that such action would not adversely affect the local economy of such county." This limit has been exceeded in some counties. In Colorado, 10 counties had reached or exceeded the limit by the fifth sign-up period, and three more are expected to reach it in the next sign up in February 1988.

The reduced payments from other farm programs is also mentioned as a negative impact on local communities. Currently, these payments are significant in counties where production of wheat and feed grains is important. Reduced deficiency payments, for example, should be recognized in the impact estimates.

Other Programs

There are other components in Title XII that may impact plowing of CRP lands. The Sodbuster subtitle provides that, if highly erodible land is plowed for annual crops without an approved conservation plan, producers are ineligible to participate in any USDA program, including CRP. Thus, plowing these lands may be economically unfavorable for many producers. Similarly, the Swampbuster provides for loss of program benefits if wetlands are plowed for crop production.

The Conservation Compliance subtitle provides that lands cultivated prior to enactment of the 1985 Act, which are found to be highly erodible, must be protected by an approved conservation system by 1995, if eligibility for government benefits is to be continued. There are no guarantees that conservation compliance will be in force in 1996 or that there will be farm programs that would significantly impact producers currently participating in CRP. As Reichenberger (1987) pointed out, "Economic climate a decade from now may not warrant participation in a farm program, if indeed one even exists at that time."

The Future

There is uncertainty as to what will happen after the 10-year contracts expire. Many remember the Soil Bank in which lands that were in the program were again plowed in the 1970's when crop prices increased. In fact, much of the acreage that is in CRP was in the Soil Bank. So these same erodible lands may again be plowed in the future if a profit can be made.

Eligibility for government programs depends on conservative use of plowed CRP lands. An approved conservation system must be in place so that the program benefits are not lost.

Supporters of CRP argue that there were no requirements on land entered in the Soil Bank regarding erodibility, so that not just highly erodible lands were enrolled. However, basic economic

theory suggests that only the marginal land would be enrolled in either the Soil Bank or CRP as the more productive land would still earn more in crop production.

Land can be used in livestock production after expiration of the contract period. But there are questions about what the condition of the permanent cover might be after 10 years of nonuse, and there is concern about impacts that increased forage resources may have on livestock numbers and the livestock industry. Protection of newly established vegetation is provided by the prohibition against grazing during the contract period. But subsequent use for livestock production is not regulated.

Use of established cover by wildlife is permitted, even encouraged, by agencies concerned with fish and wildlife habitat. New plants (e.g. trees) must be protected from damage by rodents; but grass, trees, and water may be used by birds and animals for food and cover without restriction. Fee recreation, using CRP lands, may become a valuable source of income on some farms and ranches.

Obviously, there are uncertainties with this program. Only those that enter the program before Oct. 1, 1987 will be assured of funding. After that date, funding becomes a part of the regular USDA budget appropriations process. Also, as less marginal lands are entered to meet the 45 million acre target, acceptance of higher rental bids or other incentives will be necessary to meet the 45 million acre goal. This was demonstrated in the fourth sign up with the Corn Bonus, which was an added incentive to enroll corn acreage. Total payment for this one-time adjustment to CRP was $340 million and added acreage in the Corn Belt. Over 1 million acres were enrolled in the program in Iowa alone.

Because of the uncertainties, it will be beneficial to monitor the CRP, and study the actual impacts on erosion and sedimentation, crop production, farm operations, and economic viability of rural communities. Like many government programs, the actual results may be far from the intended results. If problems can be detected early, it may be possible to make mid-course corrections that will facilitate desired outcomes. The papers to follow should give good ideas on future possibilities and factors that we should monitor to determine those futures.

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Overview of the Present Land-use Situation and the Anticipated Ecological Impacts of Program Implementation

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Abstract.--A 45-million-acre Conservation Reserve Program will reduce cropland by 25.2 million acres (15%) and erosion by 639 million tons per year while increasing herbaceous cover by 24 million acres (7%). These benefits will accrue as long as the acreage remains in permanent cover.

The purpose of this paper is to provide an overview of the land use picture in the Great Plains prior to the initiation of the Conservation Reserve Program (CRP), project the change that will occur in this pattern and to discuss the related ecological impacts. With complete data available from the first four sign-ups and some data from the fifth sign-up just completed in July, trends are readily available. The paper assumes that current trends will remain constant until the program reaches the 45 million acre goal. This is an acceptable assumption; however, significant variations from the goal could actually occur. For example, during the fifth sign-up, the Great Plains acres accepted in the program jumped from 54% to 64% of the total. If this increase should continue, the projections in this paper will be quite conservative. Therefore, it appears safe to say that at a minimum, the discussed changes will occur.

Background

The ecology of the Great Plains has been discussed by previous speakers at some length. It has been described as unique in that it is continuously exposed to climatic extremes of temperature and low precipitation. The area is characterized by high winds and plagued with frequent drought. The soils formed under these conditions are relatively shallow, but productive with adequate moisture, and very susceptible to soil erosion and degradation. Recovery from soil loss is geologically slow. Thus, it is paramount that the existing top soil and its inherent productive capacity be protected and retained.

The stability of the Great Plains ecosystem with its delicate soil, water, plant and animal relationships is a major challenge confronting us today, tomorrow and on into the future. Under the best soil, climatic and topographic combinations possible, the protective herbaceous and or woody plant cover on the soil surface varies from excellent to very sparse. In areas like the Badlands of South Dakota, with minimal natural cover, natural geologic erosion occurs at a high rate. While in other areas with more amenable climate and soils, such as the tallgrass prairie, geologic erosion is negligible if the plant communities are maintained in a healthy ecological condition. However, even in these areas of the Great Plains, the natural cover is easy to abuse and lose, or to destroy directly with modern machinery. It is also unpredictable, costly, and exasperatingly slow to re-establish.

Once the natural protective cover is destroyed, the destruction of the soil resource follows rapidly, reducing or destroying forever the inherent capability to naturally regain or maintain the protective cover it had prior to the degradation.

Yet, the people, the government, and the landowners and users continue to forget, give low priority or overlook this fragile ecological balance. A cycle of destroying the sod and exposing the bare Plains to the destructive forces of wind and water has developed. This is followed by a period of alarmed, conscientious concern and attempts to re-establish a permanent vegetative cover.

The first near destruction of the Great Plains started in the late 1920's, culminating in the dust bowl of the 1930's. This plowout can probably be credited to the lack of knowledge of the fragile ecosystem, but can also be associated with an ill-conceived land settlement program. The result was an unstable environment and mass abandonment of acres of bare soil to the forces of nature. The government set to work and seeded millions of acres back to herbaceous vegetation. Species selection was determined by cost and availability of seed. Little, if any, consideration was given to ecological compatibility with the soil and the original vegeta-

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tion. Many of these Land Utilization (LU) seedings scattered throughout the Plains remain today as monuments to man's mistake.

Round two started abut 30 years later in the mid-1950's. One could argue this mental lapse was triggered by a manipulated farm economy which sent out a signal of guaranteed grain prices. Whatever the cause, the result was another near disastrous plowout of millions of acres of the Plains and the subsequent establishment of the Soil Bank and Great Plains Conservation Program by the government to reestablish permanent cover. This time, more effort was given to match the seeded species to the soil, climate and surrounding vegetation. A growing knowledge of soil-plant relationships, use compatibility and plant management was demonstrated. When considering how ecologically sound CRP is being implemented, these three are key evaluation criteria.

However, history continues to repeat itself since man is slow to learn and quick to forget. The late 1970's and early 1980's saw the start of round 3, the plowout of the fragile Great Plains sod. Again, to try to produce crops that do not maintain adequate residue on the surface to keep the soil from eroding far in excess of its restorative capacity. The catalysts this time were distorted economic signals and shortsighted agricultural programs which fueled speculation and inflated prices for cropland. Income was guaranteed for cropping soils where crop failure and cost of production prevented profits otherwise.

So, for the third time in 50 years, the government is again involved in the revegetation of millions of acres unsuited for cropping.

Discussion

So what have we learned about the Great Plains ecosystem and how are we responding this time? How are we planning the vegetation planted to the soil, to expected future use, to the surrounding plant communities.

Let me suggest that we are improving. The figures that follow indicate we are doing somewhat better in selecting the species that fit the situation. In the acres with more fragile soil-plant relationships and where soil erosion is highest, such as New Mexico, Texas, and Colorado, more native species are being seeded. Wyoming and the other Northern Great Plains states appear to be an exception, however.

Let's take a detailed look at the changing land use picture. To date, 69,768 bids have been accepted in the Great Plains states (ASCS data). The number could increase to approximately 137,000 if a full 45 million-acre CRP is carried out, nationally. This provides an indication of the number of farms and ranches in the Plains that will be involved. Forty-two Great Plains counties have reached the 25% cropland conversion limitations (ASCS data).

Land use prior to the CRP is shown in table 1. Sixty-nine percent (385 million acres) of the private land was in a permanent cover of range, pasture, and trees. Thirty-one percent or 171 million acres was in cropland. Permanent cover varied from 40% in Kansas to 95% in New Mexico.

Table 2 shows the acres of highly erodible land in the Great Plains states that are eligible for CRP. The acreage varies from a low of 872,000 acres in New Mexico to a high of 13.9 million acres in Texas. The table also shows the percentage each state contains on a Great Plains and national basis. The main point is that 48% (49.1 million acres) of the eligible acreage is in the 10 Great Plains states. If the sign-up rate corresponded to the acreage, 21.8 million acres of participation would be expected.

However, table 3 indicates that after the fifth sign-up the Great Plains has provided 56% of the accepted acres. At that rate, if the full 45 million-acre goal of the program is achieved, a total of 25.2 million acres will be taken out of highly erodible cropland in these 10 states. Thus, almost 15% of the 171 million acres of cropland in the Plains will be taken out of crop production.

Table 4 indicates that, through the first four sign-ups, 95% of the acreage will be in permanent herbaceous cover. Permanent herbaceous cover in this case includes tame species (CP-1), native species (CP-2), and those acres already in grass (CP-10). I have shown, but will not include in the discussions, CP-3 and -11, trees; CP-4 wildlife habitat; and CP-5, field windbreaks. However, it should be noted that the wildlife habitat average is planted to herbaceous vegetation primarily, but may have woody species included to enhance food and cover value.

Table 5 provides a summary of the cover selection through the fourth sign-up for each state. Program rules were designed to allow flexibility at the local level for selecting the species that fit the situation and fulfill CRP objectives. It's obvious that the states are taking advantage of the flexibility when you study the percentage range in native and tame selections in each state.

The projections in table 6 shows the acreage of each cover type that is expected if the national CRP goal of 45 million acres is achieved. Pasture and range acreage will increase to approximately 24 million acres. This projection assumes that the cover selection pattern displayed during the first four sign-ups will remain constant.

In table 7, the projected increase in acreage of range and pasture is compared to the land use prior to CRP. The acreage of "already in grass" (CP-10) was distributed among range and pasture in the proportion CP-1 is to CP-2 (43% and 57%). The conversion will increase range by 4% and pasture by 27%. Another 1.2 million acres of cover will be planted specifically for wildlife habitat, also.

Effects

The changes outlined above will have a strong stabilizing effect on the environment of the Great Plains by initiating a regeneration of damaged soils and improvement of polluted water. To a more limited degree the change will enhance groundwater recharge and overall water yield--both critical elements of survival in the Plains. Also, the almost exclusive use of these acres by wildlife for the 10-year life of CRP contracts and

Table 1.--Pre-CRP land use (millions of acres) in 10 Great Plains states, as reported by USDA-SCS (1987) (1982 NRI).

State	Pasture	Range	Forest	Crop	Total
CO	1.3	24.2	4.0	10.6	40.1
KS	2.2	16.9	0.6	29.1	48.8
MT	3.0	37.8	5.2	17.2	63.2
NE	2.1	23.1	0.7	20.3	46.2
NM	0.2	41.0	4.7	2.4	48.3
ND	1.3	10.9	0.4	27.0	39.6
OK	7.1	15.1	6.5	11.6	40.3
SD	2.7	22.8	0.6	16.9	43.0
TX1	7.0	95.4	9.3	33.3	155.0
WY	0.7	26.9	1.0	2.6	31.2
Great Plains					
Total	37.63	14.13	3.0	171.0	555.7
Percent	6.8	56.5	5.9	30.8	100.0

Table 2.--Eligible CRP acres in 10 Great Plains states (unpublished SCS data).

State	Land area	Eligible land	
	(million acres)	Great Plains	50 States
CO	5.47	11.1	5.4
KS	7.03	14.3	6.9
MT	8.60	17.5	8.5
NE	5.03	10.3	5.0
NM	0.88	1.8	0.9
ND	2.79	5.7	2.7
OK	2.95	6.0	2.9
SD	2.04	4.1	2.0
TX	13.93	28.4	13.7
WY	0.38	0.8	0.4
Great Plains			
Total	49.1	100.0	48.4
U.S. Total	101.5	---	100.0

Table 3.--CRP acres accepted sign-up period 1 through 5. (Unpublished SCS data).

State	Accepted acres	Percent of eligible acres
CO	1,583,722	29.0
KS	1,979,917	28.2
MT	1,762,230	20.5
NE	949,358	18.9
NM	455,390	52.2
ND	1,448,885	52.0
OK	870,667	29.5
SD	846,764	41.5
TX	2,782,531	20.0
WY	215,721	56.2
Great Plains		
Total	12,895,185	26.3
U.S. Total	22,995,997	56.0

(Note: 64% of the fifth sign-up was in the Great Plains.)

Table 4.--Type of cover elected in sign-up periods 1 through 4 (unpublished SCS data).

Cover	Acres	Percent
CP-1 Tame Species	3,822,549	40.3
CP-2 Native Species	5,086,880	53.6
CP-10 Already in Grass	118,071	1.2
Subtotal	9,027,500	95.1%
CP-3 Trees	9,945	0.1
CP-11 Already in Trees	3,583	
CP-4 Wildlife Habitat	47,159	4.7
CP-5 Field Windbreaks	1,952	
Miscellaneous	870	
Total	9,491,009	99.9%

Table 5.--State CRP area (in thousands of acres) by cover type. (Unpublished SCS data).

State		Introduced grass CP-1	Native grass CP-2	Aready grass CP-10	Trees CP3&11	Wildlife Habitat CP4	Wind-breaks CP-5	Total
CO	Ac.	297.4	1,051.9	4.5	.6	67.7	.4	1,442.6
	%	20.9	73.9	.3	T	4.8	T	15.0
KS	Ac.	88.6	1,288.2	6.9	.8	6.4	T	1,391.0
	%	6.4	92.6	.5	T	.5	-	14.7
MT	Ac.	922.9	183.7	16.2	1.2	21.7	.5	1,146.1
	%	80.5	16.0	1.4	.1	2.0	-	12.1
NE	Ac.	325.0	329.4	11.6	1.2	133.6	.6	801.5
	%	40.6	41.1	1.5	.1	16.7	_	8.4
NM	Ac.	22.5	415.3	2.5	0	0	T	404.4
	%	5.1	94.3	.6	-	-	-	4.6
ND	Ac.	599.6	7.2	22.5	.4	83.1	.2	713.1
	%	84.1	1.0	3.2	T	11.6	-	7.5
OK	Ac.	321.9	375.0	10.9	T	.9	T	708.7
	%	45.4	52.9	1.5	T	.1	-	7.5
SD	Ac.	310.8	77.0	27.0	.5	40.2	.1	455.6
	%	68.2	16.9	5.9	.1	8.8	-	4.8
TX	Ac.	801.5	1,358.7	13.6	8.7	69.9	T	2,252.5
	%	35.6	60.3	.6	.4	3.1	-	23.7
WY	Ac.	132.3	.4	2.2	T	23.7	T	158.7
	%	83.4	.3	1.4	T	14.9	-	1.7
Great Plains								
Total	Ac.	3,822.5	5,086.9	118.1	13.5	447.2	-	9,490.1
	%	40.3	53.6	1.2	.1	4.7	-	100%

hopefully beyond may be extremely beneficial to wildlife populations.

Concerns related to the management and maintenance of the seedings during the life of the contract should be noted. If the vegetation is properly managed, the end result will be a viable, productive stand providing the owner many more options for use; e.g., wildlife habitat, seed production, hay, forage, hunting and other recreation, watershed protection, water yield, etc. If not properly established and managed while under contract, the stand may deteriorate to where re-establishment is needed or the area becomes a source of undesirable weeds in the community.

Several problems have arisen. Most are directly related to the sudden surge in the demand for seed and the resulting seed shortage that is being experienced. The use of short-lived perennials has increased the problem. This creates a possibility that stands will deteriorate before their contracts expires and erosion control will, therefore, not be adequate. Incompatible mixtures are being seeded. Increased seeding rates to offset use of poor quality seed has increased the total amount of weed seeds planted. Foreign seed of questionable origin and adaptation is being used. Seed testing results are questionable in some cases. Mislabeling of varieties is appearing. Seeding specifications are being altered to "ease the problem." All of these can have long range negative repercussions.

Certain other deductions can be made. First, the acres planted to trees are more likely to remain out of crop production when contracts expire. Next most permanent is the 14.9 million acres planted to wildlife cover.

Table 6.--Projected Great Plains average by cover type (assumes CRP goal of 45 million acres).

Cover	Percent to date	Projected acres *(millions)*
CP-1 Tame Species	40.3	10.2
CP-2 Native Series	53.6	13.5
CP-10 Already Grass	1.2	0.3
Subtotal	95.1	24.0
CP-3/11 Trees & In Trees	0.0	(0.3)
CP-4 Wildlife Habitat	4.7	1.2
Great Plains total	99.9	25.2

Table 7.--Projected land use change by CRP.

Use	1982 acreage	Projected CRP change	
	(Million)	*(Million acres)*	*(Percent)*
Cropland	171.0	-25.2	-14.7
Pasture	37.6	+10.3	+27.4
Range	314.1	+13.7	+4.4
Trees	33.0	+.1	+.3

Table 8.--Project reduction in annual erosion on the Great Plains through first four sign-up periods (9.5 million acres) and for projected maximum (25.2 million acres). (Unpublished SCS data).

State	Reduction	
	(Tons per acre)	*(Million tons)*
CO	26.3	37.4
KS	18.5	25.7
MT	14.3	16.4
NE	25.1	20.1
NM	41.4	18.2
ND	15.4	11.0
OK	24.6	17.4
SD	13.3	6.1
TX	38.3	86.3
WY	12.3	2.0
Great Plains Total	25.35	240.6
Sign-up 1-4 maximum	25.35	638.8

Native species may tend to have more permanency than the 10.3 million acres planted to tame species due to the higher investment and long-lived characteristic of native species.

Second, these acres can become a significant forage resource. Assuming an average of 2 animal unit months (AUM's) per acre production on the pasture added and 0.4 AUM's per acre for the range added, there is a usable potential forage production of 25 million AUM's. This is adequate forage for 2.5 million cows for 10 months. At 1.25 tons of hay per acre the 10.3 million acres seeded to pasture species could produce about 13 million tons of hay after the contracts expire.

Another alternative should not be overlooked. The entire acreage planted to tame and native species has a seed harvest potential; a good reason why it is in our best interest to seed desirable varieties. If we do, CRP presents an ideal opportunity to rapidly increase the supply of improved varieties.

Another major impact of a 45 million acre CRP will be an annual reduction in soil loss of 639 million tons (table 8). This reduction is 85% of the annual total soil loss reduction expected for the entire nation when the program was conceived. The Great Plains reduction to date is 66% of the national reduction. Compare this to the fact that only 56% of the acres accepted are in the Great Plains. Reduced erosion means less sediment, pesticide, and plant nutrient movement into waterways, thus improving the quality of water for human consumption and use, agricultural production, fish habitat and recreation.

Conclusion

In conclusion, if the CRP achieves its 45 million acre national goal, 25.2 million acres of highly erodible cropland in the Great

Plains will be re-established in permanent vegetative and woody cover. Approximately 54% of the acres will be planted to native species. This closely parallels the 56% of the land currently in range. Annual soil loss reduction averaging over 25 tons per acre will improve the quality of water and life in the Great Plains. Acknowledging that CRP appears to be achieving its erosion reduction objectives in the Plains, the ultimate challenge will continue--can we keep from repeating the mistake of tilling the fragile soils of the Great Plains for the fourth time? Hopefully, this symposium will be a first step in preventing this cycle which appears to have become a U.S. tradition.

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The Economic Impact of Farm Policy Changes on Rural Communities: Conservation Provisions--A Case in Point

Mike D. Woods and Larry D. Sanders[1]

Abstract.--The Conservation Reserve Program (CRP) highlights the fact most farm policy programs impact not only producers but also rural communities and counties where the producers are located. This is usually the case when agriculturally dependent areas are involved. The Great Plains region, including the Oklahoma Panhandle, falls in this agriculture-dependent category. This paper examines the linkages between agriculture policy and rural communities with a brief review of the literature. The CRP is briefly summarized. Data and statistics are presented for Oklahoma including a summary of observations gained from visits to highly impacted areas. Finally, an example county is analyzed in terms of the possible economic and social impacts of the CRP on the local economy.

Agricultural Policy and Rural Communities

Farm Policy and Farm Structure

Much discussion has centered on the question of farm policy impacts on farm structure. The number and sizes of farms constitutes an important topic when examining economic impacts of farm policy changes. Knutson et al. (1986) noted there are several factors affecting farm structure including technological change, economics of size, tax policies, and farm policies. Tweeten (1983) discussed several areas of public policy affecting agriculture including monetary-fiscal policy, export policy, tax laws, resource policies, as well as commodity programs for agriculture. In addition to problems caused by nature, politics and business cycles, Tweeten noted the farming industry faces cash-flow problems induced by inflation and interest rates. Regardless of the debate concerning the significant factors affecting farm structure, it is apparent farm structure is important in agriculture-dependent areas just as the future of the auto industry is important for areas deriving large levels of employment from automobile production.

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Farm Structure and Rural Communities

Tweeten and Brinkman (1976) pointed to several elements influencing community economic growth including attitudes, natural resources and existing institutions such as schools, banks, and government. Growth occurs through savings and investment depending upon the rate of resource use as well as efficiency of resource use within communities. Agricultural communities such as those in the Great Plains area of the United States have relied on natural resources in the form of agricultural production to produce growth. For those communities the existing and future structure of agriculture is important. Even among the agriculture dependent areas defined by Bender et al. (1985), the type of commodity produced varies. Thus, input purchase patterns and linkages to the community will vary. Michaels and Marousek (1978) examined the impact of farm size alternatives on rural communities in Idaho. Replacing small farms with larger farms resulted in greater regional income while increasing the number of small farms lead to greater regional employment. Other factors which were noted to be important for rural development in small towns included trading patterns and opportunities for nonagricultural development.

In a study of rural population growth, Albrecht (1986) reported counties dependent on agriculture are likely to experience population declines in the future. He noted that the rural population turnaround of the 1970s was not shared by all rural

communities. Doeksen (1987) analyzed the agricultural crisis as it affects rural communities through a case study. A lost of 20% of the farmers in a rural community was shown to impact not only employment and population, but also community service requirements and local government revenue.

Communities and Farm Well-Being

Ladewig and Albrecht (1983) reported on the changing agricultural industry in Texas and the nation. They noted the importance of off-farm employment for farm families. Due to the instability of farm income, severe cash flow difficulties, and low farm prices, many farm families depend on off-farm income as a means of continuing farming at all. Powers and Hobbs (1985) emphasized that support for rural economic development is complementary to the needs of farmers, not competitive. Even though scarce resources are available for assistance, providing help for the community in general will likely help the farm families who are trying to survive. Research aimed at understanding the linkages between farms and the rural community will strengthen this agreement and it will be useful to quantify the types of linkages by types of communities and farms.

Food Security Act of 1985

While commodity programs and spending have overshadowed discussions related to the Food Security Act (FSA) of 1985, many producers have only recently started to become aware of other significant aspects of the legislation. The conservation provisions are among those that will have potentially major impacts on agriculture and the economy of Oklahoma and other states.

The conservation provisions are intended to accomplish two lofty, yet very basic, goals. The first is a significant reduction in soil erosion. Additionally, it is hoped that such a major removal of cropland from production will significantly reduce excess capacity for commodity production. However, Congress hopes to achieve these goals without adversely impacting farm income, rural economies and the federal budget. The likely effects of these provisions will be far-reaching, including the following:

1. A decline in cropland erosion;
2. an uncertain impact on commodity production and price levels;
3. possible increase in "wildcat" farming outside government programs, thus leading to uncertain erosion effects on such land;
4. acceleration of the structural trend toward larger operations;
5. increasing stress on the economic viability of some rural communities;
6. increasing growth of some communities as trade centers;
7. possible political pressure to change policy to lessen adverse regional impacts; and
8. a decline in off-farm impacts of erosion, including an increase in water quality.

A diverse group of interested parties took part in discussions over a land conservation component in the 1985 Farm Bill during the two years prior to enactment. These included conservationists, small family farm producers, large scale operators, agribusiness and agriculture credit representatives, and agricultural organization leadership from all spectrums. At least three points were emphasized:

1. soil erosion had grown to the point that future productivity of American agriculture was severely threatened;
2. the old Soil Bank approach of the 1950's, along with other attempts, had proved inadequate; and
3. while the cost of doing nothing about erosion might prove devastating in the long run, the immediate cost of a large scale conservation program would not set well in the budget-cutting environment of Washington.

The result of such concerns was a conservation title that contained these programs: the Conservation Reserve Program, Sodbuster, Swampbuster, and Conservation Compliance. The Agricultural Stabilization and Conservation Service (ASCS) has just closed the fifth bid period for CRP. Data available from the first five periods show USDA has now approved just under 23 million ac. for CRP contracts nationwide, and over 890,000 ac. in Oklahoma.

Background

"Highly erodible land" has become the target of increasing concern during recent years. While the term is technically defined in the Bill and implementing orders, the idea is straightforward. Such land converted to agricultural production, often intensive, has pushed the average annual rate of erosion to levels that range from 10 tons/ac. to 30 tons/ac. This is contrasted with a generally accepted annual rate for all cropland of about 5 tons/ac.

Ironically, many of the federal farm programs designed to help farmers have also created the incentive to convert marginal land with high erosion potential into intensive cropland, thus worsening the problem. While good intentions and opportunity do not always coincide, the current conditions of high stocks provided the opportunity that conservation-minded policymakers were needing.

As noted in Congressional analysis of the problem, taxpayers were paying both for the incentive to worsen the problem and for

the consequences of erosion. The off-farm cost of dealing with sedimentation has been estimated to be $2 billion to $6 billion per year.

Efforts of the Soil Conservation Service (SCS) and ASCS, while noteworthy, have not kept pace with offsetting incentives to mine the soil for short-term gains. The Soil Bank did not specifically target highly erodible land. Instead, it became more of a production restriction program. Requirements for conservation cover on set-aside acreage enrolled in commodity support programs has helped somewhat. Again, however, highly erodible land has not been targeted in the past.

The Natural Resources Inventory of 1982 provided a focus for the problem. This showed about 50% of the sheet and rill erosion was occurring on only 10% of U.S. cropland. The Soil and Water Resources Conservation Act of 1977 provided for pilot projects that pointed to possible solutions. Land conversion projects were conducted in Pike County, Alabama, Stanley County, South Dakota, and Willow Creek, Idaho. More than half of the project land had been eroding at more than four times the tolerable rate. By paying landowners to stop cropping and covert back to grass or trees, preliminary results indicated success. And, more significantly from a budget standpoint, contracted acreage would save the government money on commodity price support program expenditures.

The 1985 Farm Bill Solution

The concerns over conservation issues for agricultural land were resolved in the 1985 FSA with a title that specifically targets highly erodible land to be taken out of crop production, kept out of crop production, or farmed in new conserving ways. The CRP affects highly erodible cropland planted at least 2 years between 1981 and 1985. Conservation compliance affects highly erodible land planted at least one year 1981-1985 and being farmed in 1990. The Sodbuster provision impacts anyone who farms highly erodible lands that were not planted before December 23, 1985, and do not have an approved conservation plan implemented for that crop year. The Swampbuster provision provides ineligibility rules for those who plant on wetlands converted after the date of enactment. Because implementing rules for the conservation provisions are subject to change, the producer will want to verify them with SCS/ASCS prior to making decisions.

Conservation Reserve Program (CRP)

The new CRP requires that 40-45 million acres be put under contract for long-term set-aside of 10-15 years. Implementation has been for 10-year contracts. The Bill established a minimum annual acreage placement schedule as follows: 1986 - 5 million acres; 1987 - 10 million acres; 1988 - 10 million acres; 1989 - 10 million acres; 1990 - 5 million acres.

Normally, no more than 25% of the cropland in any county can be placed under contract, although there are special procedures to request a one-time exception providing it does not "adversely impact" the economy of the region. The annual rental payment may not exceed $50,000. Generic payment in kind certificates have been designated as the form of payment in the implementation by the Secretary. The Bill allowed USDA to place under contract the entire 45 million acres as soon as possible. If payments are likely to be significantly lower in the next year, the Secretary may reduce the annual minimums for 1986-1989 up to 25%.

The contract producer must agree to the following provisions:

1. to implement the conservation plan of operation provided by ASCS;
2. to place the acreage in the CRP for 10 years;
3. to not use the land for agricultural purposes unless permitted;
4. to establish approved permanent vegetative cover (trees, native grasses and legumes, introduced grasses and legumes, wildlife habitat or field windbreaks);
5. to not conduct harvesting or grazing or make commercial use of forage; and
6. to not plant trees, unless permitted.

The SCS has estimated that 104 million acres were eligible across the nation, with 2.2 million eligible acres in Oklahoma. For the purposes of the first two bid periods (March and May, 1986), the technical criteria were simplified to all class VI and above cropland and any class II through V cropland eroding at least three times the normal soil loss tolerance. State technicians estimated that about 1.7 million ac. of Oklahoma cropland qualified.

For the third bid period in August, 1986, the CRP definition of highly erodible land was expanded to include class II through V that was eroding at two times normal and had visibly gully erosion. The fourth signup in February 1986 contained an even broader definition that essentially brought CRP eligible land into conformity with Conservation Compliance and Sodbuster. The definition is a technical index, the erodibility index (EI), based on the inherent erosion potential of the land. It considers length and steepness of slope, climate and soil characteristics. Land that has an EI greater than or equal to eight is considered eligible. The SCS estimates some 4.7 million ac. meet this criteria in Oklahoma.

Impacts of the Conservation Reserve Program

As noted in the earlier literature review, an agricultural policy such as the CRP impacts a local economy by having some effect on one of the basic industries (agriculture) in most economies. In the relationship between a basic industry, such as agriculture, and the community economic system, households are provided in-

come and, in turn, provide labor to the industry. The service sector of the economy (mainstream business such as drugstores, hardware stores, etc.) provides goods and services to the households. The service sector may also provide inputs to the basic industry (for example, agricultural inputs). The basic industry in the local economy would be agriculture. The CRP impacts that industry. Households, particularly farm families, are impacted in at least two ways. A farm income impact results from the rental payments of CRP. The flow of this income depends on the consumption and saving patterns of the farm families. An additional income impact is the cost of compliance for CRP. The service sector is impacted through changes in production patterns and input demand. Also, farm households may spend CRP rental payments in the local economy. The net impact on the local economy will depend upon the magnitude and direction of responses to changes in the basic industry.

There are several critical areas where impacts may occur when there is a change in the base of a local economy. Listed in table 1 are key areas to consider in impact assessment. The first area considered is economic impacts. Depending upon the direction of the economic change, jobs and income can be added or lost to the local economy. Overall business activity is also impacted as indirect "multiplier" effects are felt in the local economy. Demographic or population impacts can also result from a change on the economic base. Population change may occur--growth if additional jobs are available and decline if enough jobs are lost. Demographic characteristics of the local population are important to economic change. Some key characteristics include age, sex, and labor force participation. Community services will also be impacted if the population base changes. What will be the level of services and facilities required and will there be a tax base to support the required level of services? Finally, there will be social impacts in the local community as well.

Table 1.--Key impact assessment areas.

1. Economic
   - Employment - jobs
   - Income
   - Business activity
   - Direct and indirect impacts
2. Demographic
   - Population change
   - Details will vary by age-sex
   - Labor force participation
3. Community Services
   - Will depend on population impacts
   - Does excess capacity exist
   - Schools
   - Water, Sewer, solid waste, health care
4. Fiscal
   - Tax base - revenue
   - Provision of services
5. Social

Table 2.--Employment data by sector for Cimarron Co., Oklahoma and the United States, 1984.

	Cimarron County[1]	% of total	U.S.[1] *(thousands)*	% of total	Location quotient[2]
Proprietors					
Farm	604		2,637.0		
Nonfarm	290		14,753.9		
Industry					
Farm	811	.421	3,797.0	.032	13.16
Ag. Serv., Forestry Fish, other	47	.024	1,130.7	.010	2.40
Mining	51	.026	1,283.9	.011	2.36
Construction	33	.017	5,830.0	.049	0.35
Manufacturing	11	.006	19,774.9	.167	0.04
Transportation and Public Utilities	88	.046	5,681.1	.048	0.96
Wholesale Trade	59	.031	6,011.0	.051	0.61
Retail Trade	191	.099	19,237.0	.162	0.61
Finance, Insurance, Real Estate	55	.029	8,377.0	.070	0.41
Services	191	.099	28,424.3	.240	0.41
Government	388	.202	18,944.0	.160	1.26
Total	1,925	1.000	118,491.9	1.000	

[1] *Source: U.S. Department of Commerce, Regional Information System, Bureau of Economic Analysis.*

[2] *County percent of total divided by U.S. percent of total.*

The stress level in many rural communities resulting from the current agricultural crisis is an example of potential social impacts. The critical impact areas listed in table 1 can all be considered when analyzing the potential impacts of CRP. In many counties, the level of participation in CRP is so low, relative to overall agricultural activity, that the impacts will be minimal.

For the purposes of discussion in this paper, an Oklahoma county is used as a discussion focal point. Cimarron County is located in the Oklahoma panhandle at the Western tip. The county is primarily agricultural with $81.8 million in cash receipts from farm marketings in 1984. This includes $63.4 million in livestock and products and $18.4 million in crops. Cimarron county had a 1980 population of 3,648, while the county seat, Boise City, had a population of 1,761. Employment data for Cimarron county is listed and compared to U.S. employment in table 2. Of the 1,925 jobs listed for the county in 1984, 811 were in the farm industry with an additional 47 in agricultural services. A location quotient (LQ) is calculated by comparing county employment with United States employment. For each sector, the percent of total employment for the county is divided by the percent of total employment in the U.S. The resulting LQ provides evidence of the level of export activity. A LQ greater than one indicates the county is a net exporter in that sector while

a LQ less than one indicates the county is a net importer. As can be seen, the farm sector for Cimarron county has an extremely large LQ showing the importance of this sector to the local economy.

The analysis of Cimarron county employment data is continued in table 3 by calculating the level of export employment using the location quotients. For a detailed explanation of the technique used see Hustedde, et al. (1984). Of the 885 export related jobs in the county, 749 are in the farm sector. The export base multiplier is estimated to be 2.18, meaning for each additional export related job, a total of 2.18 new jobs are created.

Cimarron county was chosen as an example because of the large acreages in the county qualifying for CRP. After the first four bid periods, 148,800 ac. were approved in the county. This represents about 32% of the total farmland in the county. Bids during the first period ranged from \$5 to \$40 per acre but came in around \$40 during the second period.

At \$40 per acre, this represents about \$5.9 million injected into the local economy each year for 10 years. The secondary impacts of this income will depend upon consumption and savings patterns of the farm families receiving the money. At one extreme, rental payments and establishment cost-share funds will equal the decrease in production income. If recipient producers use this income on farm inputs following similar spending patterns as before their contract, there will be essentially no change in income flows and employment in the community. If, however, the farm family uses the CRP income for retirement of existing debt and/or non-farm enterprise consumption or saving, there will follow a redistribution of benefits away from local agribusiness and to other sectors in the local economy or a nearby trade center. In fact, existing or potential "growth pole" communities may be significant winners as a result.

Alternatively, rental payments could be greater than the decrease in production income. It is unlikely that rental payments will be less than production income, because producers are assumed to seek the more profitable alternative. If they underestimate future market conditions, they will likely buy their way out of the contract. Where rental payments are greater than the decrease in production income (and field work seems to support this likelihood), changes in consumption and savings patterns become even more critical. A result of this scenario could be that all sectors in the local community are better off, as well as nearby trade centers gaining business.

Table 3.--Estimate of export employment for Cimarron Co., Oklahoma.

	Location quotient (LQ)	% of employment serving non-local needs[1]	Employment Total	Employment Export
Farm	13.16	92	811	749
Ag. Serv., Forestry, Fish, other	2.40	58	47	27
Mining	2.36	58	51	30
Government	1.26	21	388	80
Other			628	
Total			1,925	885

[1]*Calculated as* $\left(1 - \frac{1}{LQ}\right) \times 100\%$

Employment Multiplier $\frac{1925}{885} = 2.18$

Summary

The CRP is an example of a farm policy which impacts not only agriculture but also the local economy of rural areas. In agricultural dependent counties where high percentages of CRP approved acreage exists, the impacts will be greatest. The income injected into the local economy through rental payments will benefit the local economy but the local impacts will be tempered by spending patterns and local sales leakages. Decreases in input purchases will be felt by the local farm input dealers, while increases in general consumer goods and services and savings will boost other sectors of the local economy and/or enhance the economy of a nearby trade center.

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Implications of Land Conversions and Management for the Future

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Abstract.--The Conservation Reserve Program (CRP) is a massive effort by Congress to check soil erosion on highly erodible cropland. This is to be accomplished by establishment and long-term maintenance of perennial vegetation on this land. The long-term success of the CRP depends on three critical constraints: (1) long-term financial attractiveness to cooperators; (2) social consistency with cooperator needs and desires; and (3) ecological compatibility with environment to be reseeded. Recommendations to augment program success are to phase in the program over a longer time period and provide: (1) in-depth workshops on seeding technology and equipment; (2) renewed emphasis on planning to meet the needs of clientele; (3) quantitative monitoring programs; and (4) forage management programs for stand maintenance.

A goal of the Conservation Reserve Program (CRP) is converting 45 million acres of highly erodible cropland back to perennial cover and maintaining this cover as a method of reducing erosion. An unstated goal is to maintain perennial cover beyond the duration of the CRP. In the first year the CRP registered 8.9 million acres, including over a million acres of cropland in Colorado (Bartlett and Trock 1987). Certainly, the stated and unstated goals are appropriate for the program. The targeted lands have accelerated erosion which produces great loss of soil and subsequent loss of productivity. The question is: "How can we accomplish these goals given land that has limited potential and that has lost productivity because of erosion and soil loss?"

A look at past experience in reseeding Great Plains areas indicates it has been treated with a broad-brush approach. For example, millions of acres of crested wheatgrass *(Agropyron cristantum)* have been planted in the Northern Plains of Montana, North Dakota, Alberta, Saskatchewan, and other states (Lorenz 1986). Smooth brome *(Bromus inermis)* was planted on thousands of acres in the Midwest, including Nebraska, parts of South Dakota, and Kansas. Old world bluestems or KR bluestem (*Andropogon* spp.) were planted in the Southern Plains (McIlvain and Shoop 1960). In many cases, however, the broad-brush approach did not fit all of the needs; and many of these lands have been replowed.

Seedings that remain fail to meet a particular need, resulting in reduced productivity of livestock or wildlife. Sod-bound smooth brome remains on hundreds of acres in South Dakota. These reseeded areas provide a perennial cover but provide poor to inadequate wildlife cover and very low production. KR bluestem in the Southern Plains is only fair in palatability and is low in quality during much of the year. Crested wheatgrass, planted on millions of acres in the Northern Plains, is low in palatability for mid- to late-season grazing, causing large areas to be less than optimum for grazing except during early spring. In all of these cases, these grasses did fill the need to provide perennial cover. Because of their shortfalls in the broad-brush approach to reseeding, however, much of this rangeland either failed to provide need of the producer and in some cases has been converted back to cropland because of this failure. Alternative species combinations with a more flexible approach would have increased the land's value to the cooperator and, perhaps, the longevity for these stands (Sims 1985).

Central Theme

The theme for this paper is: "What do we have to do to accomplish our long-term goals?" First and foremost, the cooperating producer is the person who implements and maintains the project and it is he who will spell success or failure for the program. A retrospective look at the basics of planning may give us an enlightened viewpoint: evaluate the goals and the resources available; build a set of alternative plans; critically evaluate the best approach with respect to goals; implement, monitor, evaluate, and alter a plan according to new information.

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We must do the best possible job of planning the reestablishment of perennial species in all the rangeland areas. Unfortunately, the CRP has become a crash program resulting, at times, in inadequate planning; accepting poor or inappropriate substitutes for seed sources, improper technique, equipment, and/or timing of the reseeding. The key considerations for success in this program over the long term are:

1. Alternatives must be financially attractive to the cooperator over the long term;
2. Alternatives must be consistent with social concepts of cooperators; and
3. Alternatives must be environmentally compatible with the area, climate, and soils for which the seeding is to be adapted.

Financial Attractiveness

Will net return to the operation be increased as a result of the practices that are being applied? This becomes especially relevant when the government no longer provides dollar incentives for continuing the program. At that time the practices must provide a financial incentive for the cooperator to maintain a perennial cover on that land. Frequently, failure to meet this criterion has resulted in land being plowed after rental payments terminate. Therefore, we have a cyclical phenomenon of plowing, reestablishing perennial cover, plowing, and reestablishing perennial cover.

The alternative chosen must be compatible with the farmer's current operation or with future plans in the operation. Failure to meet this criterion will cause the cooperator to define the alternative as financially unreasonable for him to pursue. The following are some constraints for evaluating the financial compatibility of alternatives to an operation (Vallentine 1971):

1. What type of livestock can or will use the forage crop subsequent to the time of the reestablishment program?
2. Will the seeding provide a needed special use, such as lambing or calving pasture, breeding pasture, pasture for fattening for yearlings, or winter range for livestock and/or wildlife?
3. Will the seeding reduce the amount of hay or supplements that are needed for that operation?
4. Is additional seasonal grazing needed to balance a year-long forage supply? If so, at what season of the year is that most important?
5. Will the seeding benefit other areas by allowing stocking rates to be reduced, season of grazing altered, turn-out dates delayed, or a special grazing system initiated?
6. Are special considerations such as erosion control, fire breaks, and wildlife habitat important?
7. Will new fences be required to protect the seeding or to exclude grazing to allow management of the seeding?

A consideration that must be included is whether stock water is available to the seeding or if it can be developed for a reasonable cost. How should the forage crop be managed after a stand is established? How long will a seeding last, and will the seeding have to be redone? Cash costs or out-of-pocket costs become critical considerations in the planning of these reseeding alternatives. What will the cost of maintenance be? This can be particularly important where brush or weed invasion becomes a problem because of the alternative chosen, the land type, or the particular weather following the time of seeding.

Evaluating all of the applicable considerations is the key to producing a financially attractive alternative for a cooperator. One must consider all the costs, whether they are direct costs (e.g., the cost of seed, seed-bed preparation, and weed control) or indirect costs (e.g., risk, changes in land value, tax base, etc.), balanced against the benefits or revenues that will be returned from the reseeding operation (Kerr and Dooley 1982). Other benefits, although not directly attributable to revenue, may include reduction of erosion and maintenance of long-term productivity of the land base. Increased wildlife value, whether that happens to be a commercially harvestable species or small game and birds, can be an important benefit to some cooperators.

Socially Consistent

Social consistency is a tough area to identify quantitatively. It will have a large effect, however, on whether land will continue in perennial cover. Successful programs are consistent with views and needs of cooperators (Greenwood 1986). Several key points should be considered in evaluating and planning a program. Most importantly, the activity must be compatible with the views of the cooperator. A program which the cooperator is not comfortable with or disagrees with is inevitably a failure because he or she has no commitment to the program's success. Even economic or political pressure is not sufficient for a non-committed cooperator to have a vested interest in the program. Programs must, therefore, be developed which do not have broad base formulas but are informed and custom-designed to meet the joint views of the cooperator and technical agency. Frequently, the agency must be able to sell a program to accomplish the need and pursue the job with flexibility to make the program a success. Field level decision making is the most effective way to accomplish any activity.

A program must be consistent with management interest and capability of the producer in the short- and long-term. The best technically planned and implemented seeding program will fail in the long term if the cooperating producer cannot, or will not, provide the management required to maintain that seeding.

Environmentally Compatible

The third major consideration is that any plan must be environmentally compatible. Species adaption to the need, land, and climate is a primary concern. A species or combination of species must be capable of good productivity over an extended period of time. Inherent to that is the necessity of hardiness of the species planted. The species must be drought tolerant, cold tolerant, and capable of withstanding defoliation and competitive plant pressures. Other papers in this Proceedings address this subject.

Many species have recently become available for use in reestablishing perennial cover. Both native and introduced species can fit the needs in many areas of the Great Plains. Most seed sources of "native" seed are introduced plant material because of selection and breeding development involved in the plant materials process. It seems, then, that plant material should be selected according to its ability to fit the environment and need rather than because it is purportedly a native species. Grazing types of alfalfa fit into this category and have been under-used in this program as a forb.

Stand establishment and maintenance is important to the success of the program, environmentally and economically. The best technology of stand establishment, in many cases, is not well defined (McLean and Wikeen 1984, Great Plains Agricultural Council 1966). Therefore, specifications for seeding are subject to the experience of the field people and other technical advisors. The opportunity to show cause and effect relationships, as well as support for research in new technology, has largely been ignored. This is, again, an influence of a crash program. Mitchell and Evans discuss research needs in a paper of this Proceedings.

Risk of stand establishment is a function of technology, weather, and available plant materials. In many areas of the Great Plains, the risk of seeding failure is relatively high with good conditions and very high in less than optimal conditions (McGinnies et al. 1983, Great Plains Agricultural Council 1966). Studies done in Colorado on stand longevity for seeded species indicate that 50% failure rates of stand establishment and maintenance is common. Seeding conditions in eastern Colorado are severe, and risk is a large factor in cost and long-term use of reseeded land. Even seedings that showed good stand establishment in the early years dramatically lost stand vigor in subsequent years. This appeared to be caused by both climatic and management effects.

Erosion control is a consideration in environmental compatibility. Some stands establish and provide adequate to good erosion control very quickly. However, some approaches (i.e., repeated cultivations or slow established species) can provide less than adequate erosion control, especially in early years or during adverse weather conditions.

Weed management is part of the environmental compatibility constraints. Weed control before and after seeding is critical to the establishment of good stands of perennial species. Aggressive weeds can cause large reductions in seeded stands on CRP acres; hence, weed control should be included in incentive provisions.

Special considerations of watersheds are also part of the environmental compatibility. Watershed stability and effectiveness of maintaining watershed stability are critical to the intent of the CRP. Frequently, speed of establishment is critical to special watershed conditions so that gully erosion does not develop and adversely affect the watershed over a long period of time.

Recommendations

We have discussed the considerations which must be in place to achieve long-term stability of the CRP and what is required to allow producers to maintain these stands beyond the rental period. The question is, "where should we go from here?" The following is a set of recommendations which I consider to be critical to providing the appropriate alternatives or considerations to guarantee long-term success of the CRP.

The program should be phased in over a longer period of time. This would allow time for better planning, a more even work load, seed companies to better meet increasing demands, and staggering the times when lands come out of the program. Vallentine (1983) indicated that technology and technology transfer, particularly in relation to rangeland seeding, was inadequate in some cases. To alleviate that problem, I would suggest there be in-depth workshops on seeding, seeding equipment, and seeding techniques as a cooperative project with the Extension Service, seed companies, equipment dealers, contractors, and other interested people to provide the most current technology available. Additional applied research is needed to evaluate management practices for feeding as well.

The second recommendation is to reevaluate the planning process. I feel that planning is one of the keys to providing long-term success in this program. Plans must be consistent with cooperator needs, desires, and environmental compatibilities as outlined before implementation of the plan.

The third recommendation is a sound monitoring program of the CRP activities. In other words, bring technical cooperators into the field when the people are drilling; observe how they are applying the technology; evaluate what the subsequent effects are on success of the stands. There needs to be follow-up field checks to monitor a cause-and-effect relationship. Combined with that, however, there needs to be firm quantitative criteria for field evaluation. A data base of the combined observations needs to be developed, maintained, and used. Without monitoring there will be no real feedback of program success or quantitative evaluation of planning activities.

The last recommendation is that there be firm plans for forage management after the stand is established, including residue management. Residues of perennial species should be reduced. There should be some kind of flash grazing program every third year during the vegetative growth period. Burning is another alternative. Residue management will both increase the vigor of the plants and serve as a mechanism to control residue accumulation over the time period. Additionally, I think in many cases

forbs and perhaps grazable browse plants have been largely overlooked in the plans for forage management.

I would like to see a follow-up evaluation and, perhaps, interseeding of both forbs and shrubs that would facilitate long-term management and values of these stands. These will greatly enhance seasonal forage quality and give additional forage quality in extended grazing seasons. I believe these recommendations will greatly enhance the quality of the program and the probability of long-term success of the CRP.

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Improving Ranch/Farm Success Through Total Ranch Management Planning

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Abstract.--Ranching and farming success can be improved through use of a strategic planning process. Total Ranch Management planning utilizes goal achievement through selection of tactical alternatives and operational activities within ranch and farm resources. Planning identifies achievable activities and uses the plans to monitor current progress and make adjustments to optimize opportunities and reduce risk. Effective use of limited resources requires establishing priorities that solve problems and not treat symptoms. Landowner investments should be where the highest benefits can be achieved and most productive resources conserved to improve success in the future.

Ranching and farming today has changed from the 1970's, a period marked by land appreciation, operations expansion, and increasing dependence on technology. Many ranches and farms are no longer solvent. Those that are surviving have maintained debt obligations within cashflow realities of agricultural production. High overhead expenses have been a primary cause for financial troubles. However, the real cause may have been management's failure to use adequate recordkeeping, planning and analysis tools to properly select the right things to do within ranch and farm resource capabilities.

A systematic approach is needed by most ranchers and farmers to organize and analyze information to improve decisions. "Most [managers] have learned by bitter experience that intuition is unreliable, if not downright treacherous, if used as the only basis for decision" (Drucker 1974). The use of "expert" opinion, research findings, new technology, etc., must be justified by each manager for their unique situation. What works well for one operation may have adverse effects for a neighbor. Also, the technology may work but not be the most important use of limited resources for the individual ranch or farm.

The Total Ranch Management (TRM) approach utilizes a systematic planning process from top down (strategic) to daily operations that better define the problems, assumptions, performance standards, and selected alternatives for effective use of resources. "Strategic planning is the continuous process of making present...risk-taking decisions systematically and with the greatest knowledge of their futurity; organizing systematically the efforts needed to carry out these decisions; and measuring the results of these decisions against the expectations through organized, systematic feedback...Systematic planning is necessary precisely because we can not forecast" (Drucker 1974).

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Strategic Planning and CRP

To be successful, operational activities must achieve tactical objectives that when summed together accomplish the strategic goals of the ranch or farm. The strategic goals and available resources determine the appropriate tactical solutions (enterprises) within a given market environment.

Management is fully responsible for ranch or farm performance, success and failure. Forecasting is necessary but inaccurate, hence risk and uncertainty (hedging against loss) is of paramount importance. Protecting assets is equally as important as investing assets. "All goals lie in the future and thus require forecasting" (Duerr et al. 1971); however, a rancher/farmer must succeed today in order to benefit from the future.

The conservation of natural resources requires balancing demand and supply with adequate allocation for maintenance of the system. The rancher/farmer gives up some "potential present value" as an investment to produce future renewable resources. Financial crisis situations force managers to over-extend use of resources for todays survival. Often these decisions create new crises that increase in frequency and further erode resources.

Strategic planning to conserve resources must consider the total ranch/farm operation. The needs and goals of an individual are often in conflict with that of the population. The Conservation Reserve Program (CRP), Sodbuster and Swampbuster provisions must meet strategic goals of individuals and the nation if they are

to survive. "Good" management decisions must be rewarded and chances of success improved if conservation of resources are to be encouraged. A common strategic goal for the land manager and the nation must be recognized.

Just like the rancher/farmer, national investments must be made where resources can benefit most and provide the higher rate of return. In general, ranchers and farmers are encouraged to invest on the most fertile sites rather than on areas where few benefits can accrue.

Using a TRM planning approach, problems can be better identified and solutions selected rather than treating symptoms. "The most important element in effective decisionmaking is defining the problem" (Drucker 1974). Drucker further points out that it is important to decide whether a need for a decision exists.

The CRP provisions are needed to cure past abuses and "protect" certain fragile lands. However, maintenance of the Nation's productivity hinges on the most effective use of limited resources. Selecting the right things to do, then doing them right is the key to management success.

Selecting the Right Things to Do

The following sections have been adapted from White, L. D. (1987a, 1987b) and White, L. D. et al. (1987).

Ranching and farming is many things to many people due to unique resources, personal goals, experiences, and environmental conditions. Success, like beauty, "is in the eye of the beholder." Because of the differences between individuals, a single definition or set of values cannot define successful ranching or farming. Farmers and ranchers must define success for their own operations.

Ranch/farm goals identify the desirable objectives to be achieved through management and use of available and future resources. If objectives are achieved, the work is successful. However, goals and objectives for survival are often confused with enterprise objectives and management decisions.

A decisionmaking sequence for selecting the right things to do, shown below, serves as the basic structure for developing an intelligent plan based on resources available and ranch and farm goals. Rather than deciding what to do, a manager first identifies needed responses then selects the most appropriate way to achieve those responses. What management achieves is more important than what is done.

Strategic Ranch Goals Prioritized

↓

Available Ranch Resources

↓

Select Appropriate Enterprises

↓

Enterprise Plans
(Production Calendar)

↓

Flow of Resources
(Budgets, Cashflow, Stockflow, Grazing Schedule, Etc.)

↓

Implementation And Control
(Monitor Current Conditions and Trends, Compare With Plans)

↓

Adjustments And Re-planning

Selecting the right things to do requires management to plan and evaluate from the strategic goal level (needed responses) through selection of tactical solutions (performance objectives) which determine operational priorities. These are six steps used in the decisionmaking sequence:

1. Strategic ranch goals prioritized.--Strategic goals define success for the ranch. These are what the ranching operation must accomplish over the long-term. Each year certain objectives must be accomplished in order to achieve the strategic goals. These goals identify why you are ranching, not what enterprises are selected nor goals and objectives for effective management of enterprises. Workshops with ranchers have identified four categories of strategic goals (prioritized) as follows:

a. maintain ranch ownership for inheritance to children,

b. meet family living expenses,

c. have adequate security against catastrophic losses, and

d. make profit for investment and ranch improvements.

Most ranchers were not interested in maximizing profit; rather they want to achieve goals A through C, make some improvements and enjoy ranching as a life style. This puts new light on why "good" technologies are not adopted until crisis situations require more intensification. Most new technologies require additional investment, new skills, and more intensive management. As long as a rancher can continue to meet basic wants, why change!

Duerr et al. (1971) has observed that goals can define the information needed for decisionmaking. The lack of a clear-cut and carefully considered statement of objective is one of the most common causes of failure (Fulmer 1974). However, these goals and objectives must be those most important for a operation to succeed in the future. A rancher can be successful at raising livestock but lose the ranch. Selecting the right goals that are achievable is the first step. Ranch and farm resources must be considered since they limit what can be accomplished and cannot be over-extended without deterioration of resources.

All goals should be SMART (i.e., S-specific in what is to be accomplished, M-measurable, A-attainable, R-related to other

ranch goals and use of resources, and T-trackable) (Blanchard et al. 1985). Available ranch resources limit what can be accomplished. Goals that must be accomplished must be prioritized over those that you want to accomplish. Once a higher priority goal is achieved other goals have use of remaining resources. Limiting resources must be effectively allocated and not overextended beyond recovery.

Goals are achievable through selection of enterprises (investments). Achievable goals require the rancher to utilize enterprises best adapted to ranch resources and meet consumer satisfaction at a reasonable profit. Most ranches require sale of products produced from ranch resources, although off ranch investments may be a wiser choice at times.

2. Available Ranch Resources.--Ranch resources are used through enterprises to produce the responses needed to be successful. A general listing of resources and their capacity to support different enterprises is the first step. As enterprises are selected more specific inventories showing flow of resources are needed to balance resource demand with supply throughout the year. By listing resources and potential enterprises, opportunities to change can be maintained and new enterprises adopted.

Management allocates available resources to enterprises and to maintain or improve future resources. Enterprise production is limited by resource capabilities. For example, to maintain ranch ownership and family withdrawal, the ranch may have an annual overhead cost of $50,000. A cow/calf enterprise that produces a gross margin of $150/animal unit (AU) requires a 334 animal unit range carrying capacity. At a stocking rate of 20 ac./AU-year the minimum ranch size would be 6680 ac. to break even. Gross margin is income above production costs, i.e., contribution to pay overhead. Profit is money remaining after paying all expenses.

If the ranch has additional "overhead" costs (goals and objectives) to be achieved, the cow/calf enterprise is inadequate. The goals and enterprise will have to be re-evaluated.

Overhead expenses cannot be emphasized enough. Most ranchers and farmers do a good job of managing enterprises, but their resources cannot produce enough gross margin. Many investments fail to produce needed increases over long enough time to reduce overhead. Land improvements aimed at increasing enterprise production should be considered as a cost to that enterprise, but once installed they become overhead costs to land ownership that must be paid even if the enterprise is discontinued. Unlike equipment, they cannot be sold with the livestock or crop.

Reducing overhead has a major impact on what enterprises have to produce and how close to the limit resources have to be used. The lower the overhead the more conservatively resources can be used. Profits are often used to make improvements for increased enterprise production, but a better use may be to reduce long-term overhead debt obligations as quickly as possible. When livestock prices increase, it may be an appropriate time to sell, reducing debt (lower overhead), and lease grazing until livestock prices fall. Then stock could be purchased for the next cycle.

3. Select Appropriate Enterprises.--Enterprises should be selected so that resources are effectively used to produce the highest total ranch benefits when combined. Through the allocation of limiting resources, competition is minimized and enterprises effectively convert resources to salable products. The manager must re-direct resources from areas of low or diminishing results to areas of high or increasing results, thereby optimizing the yield from these resources (Drucker 1974).

Diversification can reduce impact of single enterprise cycles, more effectively utilize certain capital improvements and equipment, and mitigate the effects of extreme environmental conditions. However, excessive complexity in a business can cause more things to go wrong. In addition, the more complex a business is, the more difficult it is to determine what went wrong and to make corrections. "No matter how desirable ... diversification is, it has to make possible concentration" (Drucker 1974).

Enterprises require different kinds and quantities of resources over time. Some compete, while others are supplementary or complimentary for use of resources. For example, cattle, sheep, Angora goats and white-tailed deer select different diets and have different gross margins per unit of forage intake. Without over use of any forage component, availability of forage resources (grass, forbs, and browse) will limit proper stocking rates for each enterprise. Because of a variety of forage resources, a single enterprise will result in one component limiting stocking rate while under utilizing remaining forage components. Optimization compares all enterprise combinations to determine the combination producing highest firm gross margin.

Overhead expenses should be reduced if different enterprise combinations cannot achieve these strategic goals in below normal rainfall years. The four factors affecting enterprise gross margin should not be overly optimistic, especially when budgets are tight, to meet critical survival goals. The four factors within each enterprise are:

1. number of production units,
2. production per unit,
3. value per unit, and
4. direct cost of production.

Once these factors are used to achieve a realistic budget they serve as enterprise performance standards (objectives).

A "balance sheet" approach is used in TRM to coordinate planning and implementation. The balance sheet allows a manager to separate components of the operation for detailed planning and combine results to evaluate achievement.

A balance sheet procedure allows managers to evaluate potential risks and gains before making a decision. Such a systematic procedure is needed to assure consideration is given to important aspects of the alternatives (Janis and Mann 1976)

4. Enterprise Production Plans.-These plans identify the necessary activities for the enterprises to effectively convert resources into products sold, thereby achieving the needed performance standards. They also identify resource requirements. Effectively managed enterprises produce the highest benefits

(optimal) from resource inputs. The more effective an enterprise becomes, the more valuable it becomes for investments of limited resources. For example, range improvement practices usually cost the same regardless of enterprise profitability, hence, the practice could be very cost effective or a poor investment, depending on enterprise effectiveness.

"Effectiveness...starts out with the realization that...10% to 15% [of human endeavor] produces 80% to 90% of the results. The other 85% to 90% [of effort], no matter how efficiently taken care of, produces nothing but costs..." (Drucker 1974). Achieving goals effectively requires enterprise plans that, when combined, demonstrate that necessary objectives can be accomplished with due consideration of risk and uncertainty of factors beyond ranch control.

5. Flow of Resources.--Since enterprises require different kinds and quantities of resources over time, resource flow plans are used to identify and budget expected resource availability and use. This allows a rancher to ration seasonal surpluses for periods when resource inflow will be inadequate to meet demand. Also, the flow plans serve as the basic monitoring tools to avoid crisis situations.

The budget and resource flow plans are the primary planning and control tools for enterprise management. The expected responses and conditions compared to the actual situation during implementation help identify when decisions are needed. Past and present records are invaluable for forecasting enterprise results, resource demands, and resource availability.

The budget process (allocating resources) serves three purposes: (1) To develop a plan that realistically will allow goal achievement; (2) identify necessary objectives (factors) that, when combined, produce the necessary results; and (3) identify enterprise performance standards and resource needs for management control. The budget summarizes enterprise management plans in numerical terms.

Partial budgeting should be used to compare alternatives. This identifies the most effective use of the available resource. If a practice has several years longevity, a partial budget is performed for each year. The present value of the net change for each year is summed to determine total present value for the investment. An acceptable interest rate is used to determine present value. The investment with the highest total present value generally is a more effective use of resources; however, flexibility and diversity to change may be invaluable, thus an alternative with lower present value may be selected based on future expectations.

Effective planning forces the rancher to analyze assumptions and eliminate, as much as possible, the elements of chance...and recognize factors that cannot be predicted or controlled. If the plan will not support the added costs of overcoming unexpected conditions, it is incomplete (Fulmer 1974). A plan that allows meeting overhead expenses should be developed for drought and poor market years; then profits in good years will be available for investments and survival is more likely.

The management plan identifies when and where certain events are expected to be completed, producing desired results under expected conditions. Completion dates are an integral part of any schedule. In addition, however, the manager should designate intermediate attainment standards, sometimes called mileposts. Such standards allow an ongoing appraisal of progress, helping to evaluate whether objectives will be achieved (Fulmer 1974). These operational level plans identify the flow of resources by enterprise, grazing unit, field, etc.

The cashflow, stockflow, grazing schedule and forage inventory, labor calendar, and production calendars identify expected and actual availability, allocation (and rationing), supply/demand balance, sources, and timetable for flow of ranch resources. Similar schedules can be developed for various farming operations and crops. Conflicts and shortages are resolved through the planning process. These planning calendars identify expected monthly status of resources, thus serving as mileposts to monitor progress for achieving objectives and to forecast potential crisis situations.

6. Implementation and Control.--Management with good plans and current information can be more effectively implemented and controlled. Good planning already demonstrates the feasibility to accomplish strategic goals. Once a workable plan is developed, day-to-day operations use these to compare with current and forecast resource flows to select priority activities and evaluate alternatives. Alternative courses of action can be evaluated before crisis situations develop.

Flow plans identify periodic mileposts for monitoring progress and trends, thus helping to prevent crisis situations through evaluation of alternatives. Through this process a rancher is better prepared to take advantage of opportunities before his or her competitors.

Accurate records showing actual resource flows serve as valuable information for future planning. Ranchers who do not have a good record of what happened only know end of year results and can make few improved management decisions.

Time allocation for developing plans, etc., must be a high priority. Otherwise, the many daily chores begin to run the business. There are always more things that need to be done or checked than time available. The TRM approach will help a rancher prioritize allocation of this non-renewable resource. Time for a ranch can only be increased by hiring more personnel, an expensive option. Therefore, personnel should be achieving needed responses rather than just working hard. Daily priorities for selecting the right things to do are based on these operational plans.

Knowing how each of the operational plans combine to affect strategic goal achievement and potential future resources helps the manager to better visualize when situations require decisions. These plans serve as monitoring and control tools to be used on a regular basis. Periodic inventory of actual conditions and use of past information concerning "normal" conditions and revised expectations of future conditions are used to readjust decisions.

More intensive management requires more frequent evaluations and decisions. Collect only the information needed. Managers can spend all their time collecting and analyzing information and fail to ranch or farm. Since cash flow summa-

rizes results of other plans, it should be updated monthly. Discrepancies will indicate the probable source. The probable cause can be tracked from the cashflow through the various plans. A daily diary of activities and observations helps better pinpoint causes.

Summary

Through this total ranch management (TRM) planning process a manager knows the economic position and ultimate goals of his or her ranching operation, as well as a plan for attaining the latter. By evaluating alternatives using economic and other criteria and measuring potential impact of decisions on resource flows and goal attainment, managers can better select the right things to do. Then, the plan must be implemented and technologies properly applied.

Selecting the right things to do requires management to develop a TRM plan from the top down to daily operations for effective use of all resources.

"Good management is the effective use of resources to accomplish the most important objectives in your ranch business...in light of the environment and competition...recognizing your relative strengths, weaknesses, and opportunities...with due consideration of assumptions or factors which cannot be predicted with accuracy...in line with consistent policies...through specific programs and projects" (Maddux 1984).

Successes and failures will continue to impact all ranchers and farmers, but the real impact will differ depending on selected goals, available resources and thoroughness of management. Most ranchers and farmers today are faced with increasingly frequent crisis management decisions. Ranchers and farmers should, after implementing a TRM plan, feel more in control of their ranch or farm and its future.

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The Effects of Different Production Systems, Technology Mixes, and Farming Practices on Farm Size and Communities: Implications for the Conservation Reserve Program

Jan L. Flora and Cornelia Butler Flora[1]

Abstract.--The paper explores the relation between farming and rural community vitality, emphasizing Great Plains farming dependent counties, and examines the impact of farm-size change and the current farm crisis on county-level sectoral income and employment, retail trade, population, etc. The influence of the retail merchandising revolution and growing transfer payments, and the Conservation Reserve Program on rural communities are also discussed.

The objectives of this paper are (1) to examine the impact of farm size and farming systems on farming dependent communities in the Great Plains and West, (2) to explore the effect of declining farm income and of expanding farm programs, transfer payments and a growing service sector on farming dependent community vitality, and (3) based on what is presented under 1 and 2, to speculate on the economic effects of the Conservation Reserve Program (CRP) on farmers and farming communities.

Farm Size, Farming Systems, and Vitality of Farming Dependent Communities

Farming Systems and Community Vitality

In 1985, we conducted a study for the Office of Technology Assessment of the U.S. Congress (Flora and Flora 1986) which examined the impact of changing farm size on the vitality of farming dependent counties in the Great Plains and the West. We examined counties located in primarily agricultural and in federal land counties which have a strong agricultural component. The analysis was limited to those counties whose agriculture is currently dominated by small grains or livestock or both. Farming dependent counties were defined by Bender et al. (1985), as being those in which at least 20% of personal income in the period 1975-79 came from farming proprietor or labor income. A small number of cases were added that did not qualify under the above mentioned criteria, but did have at least 25% of their labor force in farming. Counties that obtained 25% or more of their production value from dairying, poultry, cotton, potatoes, sugar beets, rice, vegetables, and fruits, and oil seeds were eliminated from the analysis. Counties on the eastern edge of the area that had predominately corn belt agricultural systems (consisting chiefly of coon, soybeans, and hogs) were also eliminated from the analysis.

The farming system predominating in each county was determined using crop and livestock data from the 1974 and 1982 agricultural censuses. Initial analysis indicated that irrigation was important in a number of the counties, but the presence of irrigation was reflected in the emergent farming system. With irrigation, small grain/livestock counties tended to diversify into mixed grain/livestock systems, with corn and sorghum replacing wheat and milo. Alternatively, livestock counties increased hay production for cold weather feeding where irrigation was available. Thus, four major farming systems were identified for analysis: wheat, livestock, small grains/livestock, and mixed crops/livestock. The livestock and small grain/livestock counties

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had cow/calf operations and in some instances ewe/lamb operations, while the livestock in mixed crop/livestock were chiefly feedlot cattle. Separate analyses were conducted for each of the four farming systems types, as we wanted to control the effects of farming system on the relationship between farm size and community vitality. In the end, all four farming systems types were combined when it was found that the direction of the relationships was similar for each.

The one type of farming system that was somewhat different from the others was the livestock counties, where stock cattle or ewe/lamb operations predominated (Flora and Flora 1987). Using cross-sectional analysis, we found that prior to the 1970s the livestock counties were least likely to generate economically healthy communities and prosperous families. They were characterized by a smaller population, fewer retail and wholesale establishments, lower median family income, and a larger proportion of the population in poverty (table 1). The explanation for this difference in quality of life is that livestock ranching requires fewer inputs and, generally, population is less dense in these counties. The income multiplier within the community is low because there is a tendency for ranchers to buy inputs and consumer goods extra-locally. This is partly because more ranchers have something other than farming as their principal occupation, suggesting greater absenteeism than is true for the other three types of farming.

Table 1.-- Socioeconomic and demographic characteristics of the population in livestock and other agricultural counties in the Great Plains and western U.S., 1969-1979 (from Flora and Flora 1986).

Socioeconomic variables	Livestock counties*	Other agricultural counties*
Total county population, 1970	4188	5488
Percent change in rural farm population, 1970-80	-20%	-26%
Percent change in rural nonfarm population, 1970-80	+31%	+15%
Percent change in total population, 1970-80	+5.1%	-1.5%
Operators whose principal occupation is farming, 1978	65%	79%
Retail establishments/1000 population, 1967	13.5	14.7
Percent change in # of retail establishments, 1967-77	-8%	-15%
Retail sales per capital, 1967 (in 1977 dollars)	$1937	$2819
Percent change in retail sales volume, 1967-77	+3%	-11%
Median family income, 1969 (in 1979 dollars)	$12,760	$14,287
Families below poverty, 1969	19%	14%
Change in % of families below poverty, 1969-78	-2.8%	-0.8%
Number of cases	(84)	(150)

**Means of county averages.*

The decline in retail services during the 1970s was least in the livestock counties. They showed the greatest improvement in income and the greatest reduction in poverty. Moreover, livestock counties showed population growth of approximately 5% over the decade, while the other types declined slightly in population. The population growth in the livestock counties occurred largely in the rural non-farm sector. In addition, retail sales volume actually increased somewhat in the livestock counties while it declined substantially in all three of the other types of counties. Poverty declined more rapidly in the livestock counties.

A partial explanation for the narrowing of the differences between the livestock and other farming-dependent counties is that the livestock system is one which has low management input; hence, technological change was the least of any of the county types, and the bypassing of the local community in the purchase of inputs and in consumer shopping did not increase substantially since it had already been occurring to a large degree. Also, for reasons apparently unrelated to agricultural change, livestock counties experienced growth in rural non-farm population. In the other three types of counties, the centralization of merchandising as part of the restructuring of rural retail trade had a strong negative effect on retail trade.

Thus, it may be concluded that the comparative disadvantage of livestock counties in terms of their supporting of viable communities diminished relative to the other farming systems types during the 1970s. The notable differences between livestock and other farming dependent counties prior to the 1970s shows the utility of taking farming system into account when examining the relationship of agriculture to rural community change.

Farm Size and Community Vitality

It is important to note that the time period examined in this study (Flora and Flora 1986) was very unusual in American agricultural history. In general, the 1970s was a period of high agricultural prices, expanding exports, readily available capital, and booming land prices.

Utilizing the 1969 and 1978 agricultural censuses, the independent variables were defined as (1) change in medium-sized farms (farms between 500 and 1,000 acres), and (2) change in number of large farms (those of 2,000 or more acres). The results were as follows:

The change in number of medium-sized farms was positively associated with local purchasing, while change in number of large farms was negatively associated with local purchasing (fig. 1). The dependent variables which measured purchasing within the county were "change in number of retail firms" and "change in retail sales." The reason for this positive relationship between

medium sized farms and local retail activity and the negative relationship between the growth of large farms and retail activity are the following:

1. Medium sized farmers tended to buy locally, while large farmers bought in bulk, thus bypassing the local merchants.
2. Counties with growth in large farms were more likely to have absentee farm operators who did not shop locally or who had operators who did their consumer purchasing and recreating outside the community.
3. Medium sized farms tended to use more labor per unit of agricultural product than did large farms, which were more likely to substitute capital for labor. There was a 66% increase in the average number of hired workers per farm over the decade. However, our analysis suggested that the substitution of capital for labor, phenomenon of the post-world war period, had by the 1970s begun to level off. By 1978, the average farm in the 234 counties studied hired .45 of a worker for more than 150 days of the year.

A change in medium sized farms was positively associated with population maintenance, as measured by the total population of the county and the rural non-farm population (fig. 2). Rural farm population continued to decline regardless of the change in farm structure. This suggests an important conclusion: The superior multiplier effect of medium sized farms operates largely through non-farm job generation rather than through the maintenance of a larger number of farmers in the community. In other words, the economic vitality of communities having a

Figure 1.--Change in retail establishments by change in number of large and medium farms.

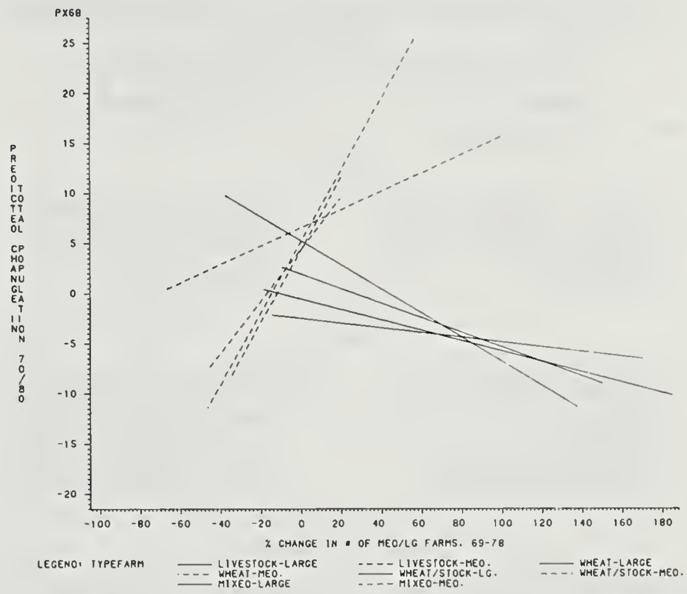

Figure 2.--Change in total county population by change in number of large and medium farms.

predominance of moderate-sized farms is due more to the buying habits of moderate-sized farmers than to a larger farm population in medium-sized agriculture compared to large-farm agriculture.

The maintenance of medium-sized farms was associated with growth in full ownership of farms, while growth in large farms was more associated with partial ownership (Flora and Flora, 1986). In order to understand these results, it is useful to introduce the concepts of yeoman and entrepreneurial farmers developed by Salamon (1985). One must also take into consideration that, although there was an overall decline in full ownership of farms by farm operators in the counties examined, the easy money situation of the 1970s tempted some moderate-sized farmers to purchase land they had been renting.

Moderate-sized agriculture is likely to have a larger proportion of yeoman farmers than is large-scale agriculture (table 2). Yeoman farmers have as their principal objective the passing of a viable farm to the next generation, while entrepreneurial farmers seek to combine land ownership and rental in such a way as to maximize profit in any given year. In simplified terms, entrepreneurial farmers view farming as a business, while yeoman farmers view it as a way of life.

The consequences of the purchase of land by moderate size farmers in the 1970s was sometimes disastrous when the rules of the game began to change in 1979. As a result of tight money, real interest rates rose and the inflated price of land began to fall precipitously. Farmers who were heavily in debt found much of the collateral that backed up those loans had evaporated. Many entrepreneurial farms who had leveraged themselves and chosen input-intensive cultural practices got caught, along with yeoman farmers who were seeking to purchase land so that they would own the entire farm to be passed on to the next generation. This was perhaps the most tragic part of the farm crisis. Not only were

Table 2.--A typology of farming types, modified from Salamon (1985).

Yeoman	Entrepreneur
Goals	
Reproduce a viable farm and at least one farmer in each generation	Manage a well-run business that optimizes short-run financial returns
Strategy	
Ownership of land farmed preferred	Ownership plus rental land to best utilize equipment
Diversify to use land and family most creatively	Manage the most efficient operation possible
Farming organization	
Smaller than average operations	Larger than average operations
Animals plus variety of crops	Monoculture cash grains
Landowners often operators	Landowners frequently absentee
Community structure	
Village central focus of community	Village declining
Community loyalty	Weak community attachment
Population relatively stable	Population diminishing

young people forced out of farming, but often they took their near-retirement parents with them if those parents had co-signed the real estate note.

By the 1980s, there had been a significant shift from proprietors' income to renters' income in agriculture (table 3). Because of the change in the factor cost of capital, it is now more profitable to rent than to own. What we cannot be sure of is whether there has been a move since the early 1980s toward a renter class (as opposed to part ownership-part rental) as occurred in the depression of the 1930s.

Table 3.-- Percentage of total personal income from farm income and property income, 46 farming dependent counties of Kansas, 1979, 1982, and 1985.[1]

Type of Income	1979	1982	1985
Proprietors' Farm Income[2]	29	20	20
Rent, interest, and dividends	20	28	27

[1]*Calculated from U.S. Department of Commerce. Bureau of Economic analysis. 1986. Local Area Personal Income, 1979-84. Volume 1. Washington, D.C.: U.S. Government Printing Office.*

[2]*Includes direct farm program payments.*

Declining Farm Income, Growing Farm Programs, Transfer Payments and Farming Dependent Communities

From the vantage point of the late 1980s, it is clear that rural communities are in trouble. The farm crisis, instability in petroleum prices, and the movement of industry from rural areas have created an air of crisis in diverse rural communities. In addition, relaxation of antitrust and tax laws favoring quick amortization and over-investment in capital goods have taken their toll on rural areas. The only reversal of those tendencies is contained in some features of the 1986 Tax Reform Law. Finally, a retail merchandising revolution has affected rural areas, independent of the other changes which have taken place.

In order to put the relation of agriculture to rural communities in context, it is necessary to look at some of the changes which have taken place in rural communities in the post-World War II period. The most important change has been an employment shift from agriculture to the service sector. Most employment growth has been in the financial sector, professional services, the health system, the educational system, and personal services.

Retail trade is the one category within the service sector which is not growing in the 1980s. For example, in Kansas the farming dependent counties experienced the greatest decline in retail sales of any category of counties - an approximate 4% annual decline in retail sales (table 4).

Why did such a sharp decline in retail sales occur in the farming dependent counties? It is clear that agriculturally related establishments, such as machinery dealerships and feed and fertilizer stores experienced a greater decline in sales for the period 1979-85 than did non-agriculturally related establishments, or those which could not be classified clearly as farm related or non-farm related establishments, such as construction firms, hardwares, garages and auto accessories firms, etc. (table 5). Furthermore, in the farming-dependent counties, agriculturally related establishments showed greater declines than they did in the nonfarming dependent counties. The mixed retail establishments also declined substantially less in the nonfarming dependent counties, in part because they were not as closely linked to agriculture as they were in the farming dependent counties. Thus, we have substantial evidence to indicate that the farm crisis has had an impact on retail sales, particularly in the farming dependent counties.

There are, however, categories of establishments which showed substantial gains in the farming dependent counties (table 6). Those include department and discount stores, office equipment establishments, and grocery and meat stores, among others. Department and discount establishments experienced a tripling of their sales during this time period. This phenomenon is what we might call the Wal-Marting of rural America. The real increase in sales of 29% by grocery and mean stores from 1979 to 1985 may be called the Seven-Elevening of rural America. There was also a rush in rural Kansas to buy computers in the early 1980s; farmers and local business persons sought them as a way to save their declining businesses. In interviews with business persons in one community in 1985, we learned that

Table 4.-- Change in total sales of all establishments by type of Kansas county, 1979-85. Taken from Kansas Department of Revenue sales tax data.

County type	% change in sales[1] 1979-1982	1982-1985	1979-1985
Farming dependent (46)[2]	-14	-13	-24
Other commodity dependent (7)	+24	-27	-10
Other Non-metro: (44)	-7	-8	-14
Service centers with commodity-dependent trade areas (10)	+2	-10	-7
Metro (8)	-8	+8	-0
State totals (105)	-7	-0	-8

[1] *Based on 1985 dollars.*

[2] *No. of counties.*

Table 5.-- Change in sales for agriculturally-related, mixed, and non-agriculturally-related establishments, Kansas Counties, 1979-85.[1] From Kansas Department of Revenue sales tax data.

Type of establishment	% change in sales[2] 1979-1982	1982-1985	1979-1985
Farming dependent counties (N=46):			
Agriculturally related establishments	-19	-33	-45
Mixed establishments	-7	-11	-17
Non-ag-related establishments	-12	-1	-13
Metro counties & other non-farming dependent counties (N=59):			
Ag-related establishments	-9	-23	-31
Mixed establishments	-2	1	-1
Non-ag-related establishments	-13	11	-3

[1] *The following kinds of establishments were defined as being agriculturally related: Blacksmith and welding shops; farm implement dealers; and flour, feed, grain, and fertilizer firms.*

Mixed establishments: accessories, tire and battery firms; and garage and repair shops; hardware and paint stores and rentals, and all manufacturing and trading firms; except printing and publishing.

Non-agriculturally related establishments: all apparel firms; all automotive firms, except accessories, tires, and battery firms, and garages and repair shops; all food-related establishments; all furniture-related establishments; all general merchandise establishments, except hardware and paint stores; public utilities; all personal and professional services; and printing and publishing firms, and most "unclassified" firms.

[2] *In 1985 dollars.*

Table 6.-- Change in sales of specific types of establishments, 46 farming-dependent counties of Kansas, 1979-85. From Kansas Department of Revenue sales tax data.

Type of establishment	Change in sales[1] 1979-1982	1982-1985	1979-1985 *(percent)*
Substantial growth			
Department and discount stores	+	+	+213
Dance, theaters, parks	-	+	+97
Variety and gift shops	0[2]	+	+59
Machinery, tools	+	+	+42
Office equipment	+	-	+32
Grocery and meat stores	0	+	+29
Substantial decline: Agriculturally related			
Metal products, pipe and steel	-	-	-71
Chemicals and products	0	-	-70
Farm implements	-	-	-47
Flour, feed, grain and fertilizer	-	-	-43
Electric equipment and supplies	-	-	-41
Building materials - new and used	-	-	-39
Hardware and paint stores	-	-	-36
Blacksmiths and welders	0	-	-32
Lumber and building	-	-	-30
Substantial decline: Other			
Cable TV, radio service	+	-	-100
Barber and beauty shops	+	-	-71
Jewelry stores	-	-	-66
Laundry and dry cleaners	+	-	-49
Automotive	-	-	-40
Lease and rentals	0	-	-40
Drug stores	-	-	-33
Filling and service stations	-	0	-32
Undertakers and funeral parlors	+	-	-30
Auto dealers and mobile homes	-	0	-29
Mens and boys clothing	-	0	-26

[1] *In 1985 dollars.*

[2] *0 in first two columns means a change of less than 10%.*

Note: Types of establishment with a change of less than 25% were omitted.

many retailers were using computers to better manage their accounts receivable.

While farming dependent counties were experiencing sharp declines in retail sales, the service center counties serving them were not declining nearly as rapidly. From 1979 to 1982, farming dependent counties in Kansas experienced an annual 5% decrease in retail sales, but the service center counties serving those areas experienced nearly a 1% annual increase. For the entire

period of 1979-85, the decline in retail trade in the service center counties was one third that of the farming dependent counties (table 4). This clearly suggests that there is a process of concentration of merchandising, resulting in the boarding up of many locally-owned mainstreet businesses in the farming dependent counties. At the same time, they are often being replaced in the nearby service center county by nationally-based merchandising firms. While the centralization of retail merchandising took place in metropolitan America in the 1950s and 60s, it is an unhappy coincidence that it is occurring in rural American during a time of economic distress.

Despite the problems experienced by farming dependent communities, by 1984 total per capita real income in the farming dependent counties of Kansas exceeded that of the state as a whole and approached the level of 1979 (table 7). The 5-year statistics are characterized by tremendous swings in real farm income in those counties, however. The sharp increase in real farm income between 1983-84 marks the engagement of the farm program and the substantial amount of PIK payments which began to fill the pockets of farmers in 1983 (fig. 3).

In addition there has been a substantial increase in transfer payments first to Kansas as a whole and particularly to rural Kansas communities in the period 1979 to 1985. The state as a whole showed approximately a 5% annual rate of growth in transfer payment receipts, which includes retirement payments, medical and disability, and income maintenance programs. In 1985, farming-dependent counties received nearly 17% of their total personal income from transfer payments (up from 12% in 1979), and non-metropolitan oil-dependent and manufacturing counties received an even higher proportion of their income through transfer payments (table 8).

The fact that these types of counties received a larger than expected share of the state's transfer payments is due principally to the age structure of the counties. Many farming dependent counties have over 20% of their population over 65, more than double their percentage at the beginning of World War II. When the transfer payments are added to farm payments, which since 1983 represent over half of net farm income in the farming dependent counties, it is apparent that governmental payments represent a substantial portion of county income in the mid 1980s. Figure 3 suggests that the farm payments may decline substantially in the next few years. Thus, the apparent well-being of farming dependent counties may change substantially, since the prospects for improved market prices for major commodities are not good, even though the dollar has experienced a substantial decline vis-a-vis the other major currencies over the past two years.

On the other hand, transfer payments can be counted upon to remain stable, if not to increase slightly. Communities that value their elderly citizens and set out to improve their quality of life, as well as citizens in general, will, if they work creatively, expand the numbers of jobs in rural communities more readily than

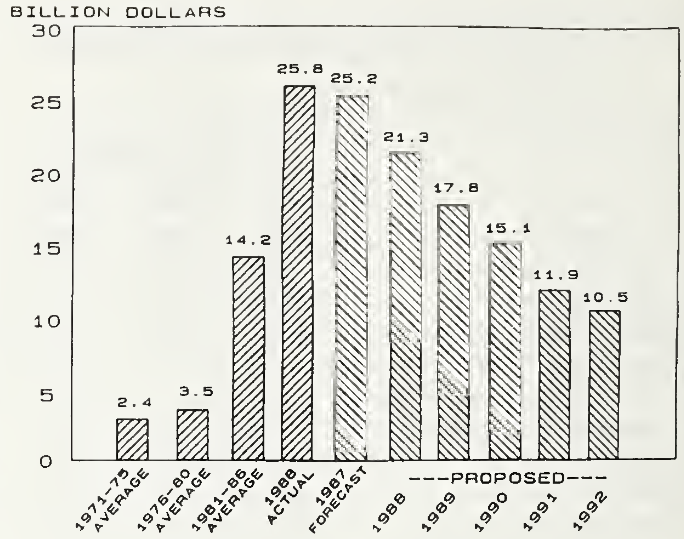

Figure 3.--Net outlays for U.S. farm programs.

Table 7.--Changes (in percent) in farm and per capita income, 46 farming dependent counties of Kansas, 1979-84.[1]

	1979-1980	1980-1981	1981-1982	1982-1983	1983-1984	
Change in real farm income (46 counties)	-53	+49	-10	-36	+70	
Real per capita income[2]	1979	1980	1981	1982	1983	1984
	(thousands of dollars)[2]					
Farming dependent counties (N=46)	14.5	12.3	13.8	13.6	12.7	14.4
Kansas	13.6	12.8	13.0	13.1	13.0	13.8

[1]*U.S. Department of Commerce. Bureau of Economic Analysis. 1986. Local Area Personal Income, 1979-84. Volume 1. Washington, D.C. Government Printing Office.*

[2]*In 1985 dollars.*

Table 8.-- Percentage of total personal income represented by transfer payments, selected groups of counties, Kansas, 1985. From U.S. Department of Commerce, Bureau of Agricultural Economics. Transfer payments tape.

County group	
All non-metro counties (97)[1]	16.7
Farming dependent (46)	16.6
Petroleum dependent (7)	19.5
All metropolitan counties (8)	11.3
Kansas (105)	13.7

[1]*Number of countries.*

through efforts to expand markets for major agricultural commodities or providing incentives to industrial firms to locate in their communities. Unlike deficiency payments, the payments from the CRP, at least for the next 10 years, can be depended upon as a stable form of income to farming-dependent communities, much as social security can be depended upon.

Effects of the Conservation Reserve Program on Farmers and Communities

The impact of the Conservation Reserve Program on communities must be assessed in a two-step process: we must first examine its effects on farmers; then we can surmise its impact on communities. The impact will vary by type of farming system.

Effects on Farmers

The CRP will definitely contribute to the stabilization of farmers' incomes. The direct effects are not unlike those of deficiency payments and other parts of the farm program. The critical difference is that the level of payments through the CRP can be anticipated for a 10-year period, thus allowing farmers to engage in long term planning. Levels of deficiency payments for the short term -- and certainly for the medium term -- are subject to political determination.

Indirect effects of the CRP, through prices of agricultural commodities, will likely be negligible. Taking highly erodible and fragile land out of crop production is not likely to significantly affect the current oversupply of the major farm-program commodities. This, of course, assumes that the CRP is not expanded to become an income support program to replace deficiency payments as they are gradually phased out. Yield-enhancing inputs will be concentrated on the better land kept in cultivation and per farm output is likely to drop very little, except in cases where most or all of the farm is put in the CRP.

Diversification of income is highly related to income stabilization. The income from the CRP can be viewed as comparable to the raising of an additional crop -- one for which yields and income are not cyclical during the 10-year period of the program. Though income from wheat, corn, or soybeans may dip in a particular year, the farmer can plan for income from land in the CRP. It is unclear how stabilization and diversification of income in this modest "farm enterprise" will affect farmers' decision-making in other enterprises and off-farm activities. That undoubtedly depends on the kind of farmer and farming system.

It is likely that the CRP will be more creatively used by the yeoman farmer over the entrepreneurial farmer (table 2). This is particularly true if the CRP becomes the dominant form of farm subsidy payments, e.g., should deficiency payments be gradually reduced or phased out. There are a number of reasons for this:

1. Yeoman farmers are more likely to be located in areas where the subsidized commodities are not dominant and to have combined crop and livestock operations; farm payments go disproportionately to large farmers, who tend to be entrepreneurial and are more likely to be specialized.
2. If they are in an area where the major subsidized commodities are grown, yeoman farmers are more likely to diversify their crop and livestock production if non-conservation related farm payments are reduced to the point that farmers are released from the necessity of growing subsidized crops. Entrepreneurial farmers are likely to continue to keep the simpler farming systems, even if the prices of wheat, corn, soybeans, and cotton remain low. Yeoman farmers are more interested in risk reduction, and the CRP offers that.
3. Since it is the entrepreneurial farmers who are more prone to be in financial difficulty (Jenkins 1986), substantial numbers of this group will go out of business. Yeoman farmers will benefit more from the CRP merely because a higher percentage of them will remain in farming. CRP payments are not likely to have a significant impact on keeping farmers from going out of business because of heavy indebtedness.
4. A wild card is whether the added income from the CRP will facilitate purchases of additional land by entrepreneurial farmers with no significant debt. We need to examine the behavior of out-of-debt farmers currently in the farm program to determine if they are buying land with the income from deficiency payments.

Part-time farmers will benefit from the CRP more than larger farmers. It will release them from part of their farm work so family members can work more hours off-farm, or it will provide a nest egg which can be used for investment in more intensive farm production, perhaps the adding of a new enterprise. Thus, the CRP can be expected to modestly strengthen the competitiveness of certain smaller, part-time farms. This generalization will not be applicable in the areas of the Great Plains where the largest amount of erodable land is located, since those tend to also be areas where population density is low and alternate employment is scarce.

Effects on Communities

The impact of the CRP on communities will not be great, except in areas with large amounts of highly erodible land, such as in parts of the western Great Plains, simply because the income effects of the CRP will be substantially less than the current impact of other farm payments, particularly deficiency payments. Nonetheless, some impacts can be discerned.

CRP payments, as at the farmer level, will provide steady income to the community for a 10-year period. Such payments are more like social security payments than deficiency payments

in their effect on the community because of their greater long-term stability. The important questions regarding their stimulation of the community's economy include the following:

From earlier studies, we already know that farming has a greater positive economic impact on the community in medium-farm communities than in large-farm communities. More of CRP payments will be circulated in the local community if it is a medium-farm rather than a large farm community.

Medium farm communities have a higher proportion of owner-operated farms than do large farm communities. CRP payments are supposed to be divided between landlord and tenant in proportion to their share of the crop. Apparently the norm is that the cost of seed, seedbed preparation, and planting also be divided in the same proportion, although that can be negotiated between the two parties. In the case of cash rent, both cost and benefit are to accrue to the tenant.

Local ASCS committees (composed of three farmers who collectively know the farms in the county pretty well) are supposed to guard against a landlord evicting a tenant, signing up for the conservation reserve, and then renting only the land not in the conservation reserve to a new tenant. In the more egalitarian Great Plains, it is likely that there will be few abuses which deprive the tenant of CRP payments. Where there is substantial social distance, as in the South, tenants may find themselves divested of CRP payments, just as they were deprived of AAA payments in the 1930s.

The rules parallel those for division of deficiency payments, but the potential for abuse is greater, since the land is taken out of production permanently, and therefore it is easier to divorce production from payments. This will occur particularly where farmers decide to retire and put land in the CRP before turning the farm over to the renter. Should the retired farmer choose to retire in Arizona or California, those payments will be lost to the community and the region. Additional research is needed to ascertain whether this practice is taking place to a significant degree. Results from such research should also have implications for assessment of leakage from the community of CRP payments.

The capacity to turn over money within the community may vary by distance from a metropolitan center or service center, community spirit, aggressiveness of local business persons, population density of the area, and other factors.

The CRP will have a negative impact on sales of input suppliers. Perhaps the impact on the sale of machinery will not be great, since most farmers will still need about the same array of tractors, harvesters, and other implements that they previously had. In the short term, anything which puts money in farmers' pockets is likely to contribute to increased machinery sales, since farmers have long delayed replacing old machinery. However, they may move to machinery rental, as the tendency to over-capitalize, spurred by tax breaks, has been reversed. This will change the nature of machinery dealerships.

Where whole farms go into the CRP or where the maximum proportion of cultivated land which can enter the CRP is raised to 35% or perhaps more, there may be a serious decline in input purchases and a crisis may arise in associated communities.

Decline in tractor fuel and spare parts sales is likely to be proportional to the decline in land in crops as a result of participation in the CRP. Fertilizer sales will decline less in areas where farm-program commodities are grown if deficiency payments are substantial, because farmers will tend to fertilize reduced planted acres more heavily. Pesticide sales may decline, depending on whether the CRP acres are hosts to pests which attack adjacent crops. However, consumer services should be enhanced by the added transfer payments available to the community.

Given the depressed farm economy and prospects for its continuation, the CRP should have a positive impact on retail trade and general economic activity in most rural communities. Unfortunately, the restructuring of the U.S. economy and the malling and Wal-Marting of rural America will more than offset whatever positive effects the CRP may have, while the CRP's negative impact will be clearly noted in areas with a high proportion of erodible land. In certain areas where CRP land provides habitat for wild game, there may be positive income impacts from lease hunting and from hunters' purchases in the community. This is not likely to occur on a significant scale in the more arid parts of the Great Plains.

In the long run, we hypothesize that healthy communities and ecologically sound treatment of the land will go together We propose that yeoman farmers will be more likely to keep land in a conservation reserve regardless of government incentives, just as they are more likely than entrepreneurial farmers to shop locally and to support local schools and hospitals. Studies which attempt to explain conservation behavior generally find little or no difference between owners and renters, farmers' educational levels, and other socioeconomic variables (Carlson, Dillman and Lassey 1981, Ervin 1986, Hooks et al. 1983, Korsching et al. 1983, Nowak and Korsching 1983).

Napier, et al. 1986, found that, as the scale of farming operations increased, soil conservation practices were used somewhat less frequently. Farmers with integrated crop and livestock operations used conservation practices more often. Highly capitalized grain producers were less likely to use conservation tillage practices (Napier et al. 1984). These results are consistent with the hypothesized relationship between yeoman agriculture and conservation behavior. Flora (1987) reviewed the results of these and other conservation behavior studies.

Perhaps the yeoman-entrepreneur dichotomy will be a better predictor of conservation behavior than are traditional socioeconomic variables. Commitment to farming as a way of life implies a long term view as does conservation behavior.

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Anticipated Changes in Rural Communities Due to Financial Stress in Agriculture: Implications for Conservation Programs

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Abstract.--Existing literature focusing on the farm financial crisis is examined in the context of possible impacts on individual land operators and rural communities. Potential environmental consequences of the farm crisis are noted and policy implications discussed.

Rural residents throughout the United States are being subjected to many change forces that will undoubtedly result in modifications in the social structure of affected communities and in the life styles of people living within them. The stimuli for change range from rural industrial development to loss of service function.

Each stimulus for change has somewhat different impacts on community groups. Some change forces have very significant and long-term impacts, while others have relatively minor influence and are short-lived. Given the variability of impacts associated with different stimuli for change, it is very difficult to predict specific outcomes of change forces on community groups. However, knowledge of existing social impact assessment research combined with awareness of situational conditions of rural populations provide a means of anticipating what some of the impacts will be on affected groups.

One of the most important change forces presently affecting rural populations within the United States is the financial crisis in agriculture. The socioeconomic consequences of the farm financial crisis have the potential to influence rural life and living for several decades. The purpose of this paper is to provide a general overview of the factors contributing to financial stress in U.S. agriculture and to employ existing knowledge about social impact assessment to predict possible outcomes on individual land operators and community groups. The potential impacts of the conservation components of the Food Security Act of 1985 for reducing the adverse consequences of the financial stress of farmers and ranchers in the U.S. may be substantial; hence, they have long-term implications worthy of examination.

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The Magnitude of the Financial Problem in U.S. Agriculture

Considerable evidence exists to demonstrate that a substantial number of farmers and ranchers in the U.S. presently have a serious financial problem. Using debt to asset ratios as a measure of economic viability of farming enterprises, research (Petrulis et al. 1987) reveals that approximately 12.7% of all farmers and ranchers in the U.S. have a potential financial problem (debt to asset ratio of 40-70%) and that an additional 4.6% have a very serious problem (debt to asset ratio of greater than 70%).

Land owners with debt to asset ratios above 70% will have considerable difficulty servicing their debt and run serious risk of losing their farms. However, the probability of economic failure declines as the debt to asset ratio decreases in magnitude. Fortunately, the greatest number of financially stressed land operators are in the 40-70% category, which suggests that a large proportion of financially stressed farmers and ranchers will survive with careful economic planning. Petrulis et al. (1987) support this observation when they note that approximately 11.2% of the farmers and ranchers in this society are actually experiencing financial stress. Many of these land operators will survive the financial crisis, suggesting that a relatively small percentage of farmers and ranchers will be forced to leave agriculture in the near future.

The loss of a small percentage of farmers and ranchers will not seriously affect U.S. agriculture in the aggregate, but regional and local impacts will probably be significant, at least in the short-run. The socioeconomic impacts of the displacement of debt-ridden land operators will be masked on the national level because the greatest majority of farmers and ranchers will

continue to enjoy relatively good life styles and will have financially secure agricultural operations. Massive poverty among agriculturalists will not be present. Production of food and fiber will not be threatened because the land of displaced farmers and ranchers will be transferred to other owners and will be maintained in production agriculture.

The socioeconomic impacts of the farm crisis on the regional and local levels will probably be substantial until the restructuring of the agricultural system is complete and community groups have accommodated the changes being introduced. This is particularly true in regions of the U.S. which are presently experiencing disproportionate financial problems in agriculture. Several authors (Brooks et al. 1986; Bultena et al. 1986, Johnson et al. 1986, Murdock et al. 1986) have shown that the Corn Belt, the Northern Plains and the Lake States have disproportionate concentrations of financially stressed land operators. Communities in these areas should prepare for substantial socioeconomic changes in the next few years.

Factors Contributing to the Farm Crisis

To ascertain what some of the potential long-term impacts of the farm financial crisis will be on individual land operators and rural communities, it is necessary to examine the causes of the financial problems. To accomplish this task, it is helpful to examine the structure of agriculture during the past five decades.

Several change forces have been in operation for many years within the U.S. which have culminated in financial stress being experienced by many land operators. Farming has traditionally been characterized as being; (1) based primarily on complex technologies, (2) energy intensive, (3) production oriented, and (4) concerned with efficiency.

Technological innovations combined with a farming system that emphasized specialization resulted in a system of agriculture which placed high value on increasing size of operations. Many agriculturalists observed the success of the high-scale farming approach and began to adopt similar techniques, technologies, and ideologies. American farmers and ranchers accepted the belief that success in agriculture demanded continual expansion of technologies and farm size. High-scale farming became the symbol of American agriculture and became the model which all entrants into the system attempted to emulate.

The rewards received from the high-scale agricultural system were traditionally very high (Napier and Forster 1982, Swanson et al. 1986). Productivity and efficiency in agriculture increased rapidly, while the demand for labor decreased. Substitution of technologies for labor progressed rapidly. Farmers who did not adopt new technologies or refused to leverage assets to purchase more land soon discovered themselves in a disadvantaged position relative to farmers willing to do so. Farmers and ranchers were continually pressured to expand production to survive in the highly competitive farming system. Survival required adoption of more energy intensive technologies, greater specialization of production, more chemical inputs and more land in production.

Values supporting high-scale forms of agriculture began to emerge and were quickly adopted. American agriculturalists began to accept new value orientations about credit, use of leveraging, orientations about land resources, and farming as a life-style. Conservative use of credit frequently resulted in farmers becoming antiquated in terms of farm technologies and smaller in size relative to other land operators. Farmers and ranchers who were willing to assume greater risk tended to leverage assets and to expand operations. They also frequently prospered. Friends and neighbors who observed the successes of large-scale agriculturalists began to adopt the same approach.

The system described above was seldom challenged because it was so successful in satisfying the production and efficiency criteria used to judge agriculture at the time. Farmers and ranchers continued to expand operations under the assumption that real interest rates (interest rate minus inflation) would remain low. This assumption appeared to be valid because land continued to increase in value and inflation remained relatively high until the late 1970s (Swanson et al. 1986).

Individuals who wished to enter farming in the late 1970s were forced to pay inflated prices for farm land and to assume high and fixed rates of interest on borrowed money. The problem was further compounded by the fact that entering farmers had internalized a desire to adopt the high-scale system which necessitated larger land holdings and the purchase of very expensive technologies. Young farmers were forced by circumstances to become highly leveraged. More established farmers and ranchers who wished to increase their social status also adopted the same expansion strategy. The result was a highly leveraged group of farmers and ranchers who made an incorrect assumption that inflation would remain relatively high and that land values would continue to rise.

Several national and international situations, which were beyond the control of those in agriculture, intervened to invalidate the assumptions made about the future agricultural economy. Inflation was controlled, and the value of the dollar relative to other international currencies increased and remained high, thereby affecting international trade of food and fiber products. Prices for agricultural products remained relatively low, domestic recessionary trends undermined the land market and land values declined substantially. These factors ushered in an era of severe hardship for highly leveraged farmers and ranchers which will be felt for many years.

The Distribution of Costs Associated with the Farm Crisis

Another factor which affects the potential impacts of change stimuli is the distribution of costs and benefits. The social and economic costs associated with the farm crisis, like the costs attached to most changes, have not been equally distributed by region or by socioeconomic group. The differential decline in the value of farm land by region is a good example. Agricultural land in the Corn Belt decreased as much as 50% between 1981 and 1986, while land values in the Lake States and the Northern

Plains declined by approximately 40% during the same time period (Petrulis et al. 1987). Land values in other areas of the country were much less affected.

Real wealth of many farmers and ranchers in the Corn Belt decreased by almost half, which left many with debts that exceeded the value of their farms and ranches. Many agriculturalists in these areas encountered severe financial problems in the 1980s which will ultimately restructure many rural communities and will influence the life-styles of affected people for many years. Similar situations are being observed in the Northern Plains and in the Lake States.

The irony of the present farm crisis is that, while a significant minority is suffering extensively, the majority of land operators have enjoyed some degree of prosperity. A large number of farmers and ranchers who did not leverage their wealth during the growth period of the 1960s and 1970s have remained relatively prosperous during the stressful period of the 1980s. Henderson[2] recently calculated real cash income per farm and demonstrated that farmers and ranchers will enjoy the most prosperous year in 1987 that they have experienced since 1973. This is significant because 1973 is considered to be "the best of times for U.S. farmers in recent years."

It should also be noted that prosperity in agriculture today is not equally distributed by socioeconomic status. Part-time farmers with small land holdings enjoy relatively good economic security as do operators of larger farms and ranches (Brooks et al 1986). Recent research findings strongly suggest that operators of middle size farms and ranches who entered agriculture during the late 1970s and early 1980s are disproportionately represented in the financially stressed agricultural group.

Total family income for different agricultural groups tends to reflect recent trends. Income data indicate that part-time farmers and ranchers have more family income than middle size farmers because nonfarm jobs are subsidizing farming operations (Brooks et al. 1986). Large-scale farmers and ranchers have the highest income levels due to longer tenure in farming and lower debt to asset ratios. Household income of part-time farmers and large-scale land operators is often above national and regional averages (Brooks et al. 1986).

Examination of the historical factors contributing to the present agricultural financial situation suggests that operators experiencing financial stress at the present time should have the following characteristics: (1) Younger people with few years of farming experience; (2) better educated people who are more recent graduates of an educational system demanding more education than in the past; (3) individuals with greater access to agricultural information systems since they have learned to value scientific information from extension and colleges of agriculture; (4) people with larger families since younger people tend to be in the active years of the family life cycle; and (5) individuals with larger farming operations and gross farm income because leveraging has produced larger operations and greater gross sales.

[2]Personal communication with D. R. Henderson, 1987, Department of Economics and Sociology, The Ohio State University, Columbus.

Recent empirical evidence tends to support these conclusions (Bultena et al. 1986, Henderson and Frank 1985, Murdock et al. 1986). The findings from these and others studies indicate that farmers and ranchers who are most stressed by high debt to asset ratios tend to have the expected characteristics. While the amount of explained variance in the models developed to predict debt to asset ratios has been very low, the patterns have been consistent.

The Potential Social Impacts of the Farm Financial Crisis on Rural Community Groups

The social impacts produced by the agricultural financial crisis vary as a function of the characteristics of the farmers and ranchers experiencing the greatest financial stress and the proportion of resident population directly affected. While community groups are very resilient and can accommodate substantial change (Bowles 1981, Napier 1981, Napier et al. 1986, Savatsky 1986, Summers et al. 1976), they are subject to temporary disequilibrium caused by change forces that exceed their ability to adjust. As the magnitude of the disruption caused by change forces increases, the amount of restructuring required to bring about a relatively stable life style within affected community groups is increased. In the context of the financial crisis noted above, the adverse impacts have been substantial for a specific minority of the farming and ranching community. Agriculturally-based community groups in the Lake States, the Corn Belt and the Northern Plains should prepare for considerable restructuring and an increase in the incidence of social problems.

Some of the potential sociological impacts of the farm financial crisis on communities significantly affected by financial stress are as follows: (1) personal and family problems associated with loss of life style and social status; (2) displacement of farmers and ranchers from agriculture into nonagricultural sectors; (3) possible loss of population due to emigration; (4) decline of local community infrastructures due to loss of population and tax base; (5) increasing scale of local agricultural operations due to purchase of land owned by displaced operators; (6) immigrants to the communities who may be entering agriculture for the first time; (7) exposure of local people to different life styles of recent immigrants; (8) changing leadership due to out- and in-migration; and (9) changed attitudes and values of land operators who remain in agriculture.

Personal and Family Problems

The personal and family problems associated with the farm financial crisis are numerous. Loss of status can result in personal estrangement from family and friends (Napier and Camboni 1987). Deviant behavior in the form of family conflict, substance abuse, and psychological problems may emerge (Hargrove, 1986). The Heffernans (1986) observed extensive pathologies among debt-ridden farmers in Missouri. Financially stressed

farmers were shown to be less involved in leadership roles, exhibited greater depression, and were less frequently in communication with other family members. While the number of families included in the research was relatively small, the study indicated that financial stress contributed to psychosocial problems.

If these types of pathologies become widespread among economically stressed farmers and ranchers, "helping agencies" in rural communities will probably become overwhelmed. The ability of most rural social service agencies to address psychosocial problems on a large scale have traditionally been inadequate. Should social pathologies become problematic on a large scale, limited community development resources will have to be redirected to improve existing support services. Such reallocation of resources will necessitate extensive change in development priorities for most rural communities. Long-term development goals may have to be deferred to provide aid to financially stressed farmers and ranchers who have never before been clients of public social services.

Displacement of Farmers and Ranchers From Agriculture and Structural Impacts

The existing literature suggests that younger, more highly educated people who are operating intermediate size farms and ranches are the most adversely affected by the farm financial crisis. If such people are forced to leave agriculture and their home communities, significant shifts will occur in terms of population characteristics of affected community groups. Rural communities will become older than they presently are which suggests a higher proportion of dependent aged and fewer young people with children. Such population changes suggest that rural communities will have increased problems of financing adequate public services. Community groups will also experience significant shifts in terms of the type of services provided. Past investments in public education could be lost, since the demand for such services would be diminished by emigration of young people with school-aged children. Ultimately, the quality and quantity of several public and private services should be reduced as a result of emigration of young families.

Declining populations will also generate considerable loss of commercial activity in affected communities and could result in the emigration of specialty businesses requiring larger population bases to sustain them. If these changes occur, the trade function of many agriculturally-based communities will be adversely affected.

Immigration should also be expected in some communities affected by the farm financial crisis. Given the relatively low price of agricultural land at the present time, it is highly likely that some people who have been unable to enter farming and ranching due to the inability to purchase land will do so. If outsiders decide to invest in agricultural land, people living in affected rural communities will probably be subject to additional change forces in the form of exposure to different life styles. While research has shown that recent immigrants to disrupted communities are quickly assimilated into restructured groups (Napier et al. 1985), there is a period of disruption for long-term residents. If values, beliefs, attitudes and behavioral patterns of immigrants are substantially different from those of local people, considerable adjustment will be required on the part of long-term residents.

Leadership of community activities may shift significantly as a result of population change. Past leaders may lose their high status in local community groups because they have lost their farms or ranches. Leadership positions may be assumed by recent immigrants or by more prosperous local residents who have never held such positions. In such a situation, extensive change may be introduced as the new leaders assert their influence and restructure priorities.

Changing Values and Attitudes

The farm crisis can adversely affect the basic culture of affected people. Bultena et al. (1986) suggest that some values and attitudes will change as a result of the farm financial crisis. They suggest that perceptions about leveraging by farmers and ranchers who survive the financial crisis will become much more conservative. While this is undoubtedly true, it must be recognized that farmers and ranchers who have prospered during the present situation successfully used leveraging in the past. The major difference between the successful land operator today and those with significant financial stress is that many of the successful farmers and ranchers used leveraging at a different time period and were more conservative in the use of debt. It is highly likely that these people will continue to value use of credit, but only when it is carefully planned and controlled.

Bultena et al. (1986) also suggest that farmers and ranchers will probably become less innovative in terms of the adoption of new technologies. Such an outcome is possible; however, it is also plausible that farmers and ranchers will quickly adopt new innovations that can be expected to provide short-term profits. Innovations in agriculture not capable of producing short-term profits will probably become less attractive.

Bultena et al. (1986) are probably correct that farmers will be more reluctant to adopt new farm technologies that must be purchased with credit. Deficit spending could adversely affect the land operator's ability to accommodate debt load. Farmers and ranchers who were conservative in the use of credit during the 1970s and early 1980s will undoubtedly be more committed to such an orientation in the future.

All of these predictions are based on the assumption that trends in land values will remain basically the same as they are presently or will increase slowly. If land values remain depressed, the scenario outlined above will probably be realized. If land values increase rapidly and commodity prices increase substantially, it is highly likely that traditional patterns of optimism will be embraced by agriculturalists. Old patterns of financing farming operations and willingness to assume risk may once again be adopted.

The Farm Financial Crisis and the Conservation Components of the Food Security Act of 1985

The financial difficulties being experienced by many agriculturalists in the U.S. will have an affect on their future soil conservation orientation. The impact of the financial crisis on volunteer adoption of soil erosion control practices at the farm level will undoubtedly be quite negative. However, the monetary incentives associated with the Conservation Reserve Program (CRP) of the Food Security Act (FSA) of 1985 will encourage adoption of soil erosion control practices in an indirect manner. Unfortunately, the positive impacts of the CRP will probably not be adequate to offset the adverse impacts of the farm financial stress, given the present value orientation of agriculturalists toward investment in soil erosion control practices. Subsequently, the net effect of the farm crisis on the adoption of soil conservation practices at the farm level will probably be negative. The basis for the prediction is presented below.

Many factors have contributed to contemporary soil conservation behaviors of land operators in the U.S. One of the important variables relative to volunteer adoption of soil erosion control practices is perception of responsibility for internalizing the costs of adoption. Recent research conducted in Ohio demonstrated that a large proportion of farmers believed they should not be responsible for assuming the economic costs of adopting soil erosion control practices (Napier and Camboni, 1987). Respondents believed that the cost of agricultural pollution was the responsibility of society rather than individual farmers and ranchers. Such beliefs make it convenient for them to ignore problems caused by soil erosion and to rely heavily on government subsidies to finance adoption of soil control measures at the farm level.

Such findings are consistent with historical evidence. Examination of soil erosion programs in the U.S. strongly suggests that farmers have traditionally been reluctant to invest in soil erosion control practices when there have been significant economic and/or human costs associated with adoption (Camboni and Napier 1986). As the economic and human costs associated with adoption of soil erosion control practices increase, the probability of adoption tends to decrease.

While farmers and ranchers will probably continue to hold positive attitudes toward soil conservation as an abstract concept, many will become even more unwilling to invest personal resources on conservation practices that will not produce offsetting economic returns in the short-run. Such an orientation will result in a significant decline in volunteer adoption of erosion control practices because most soil conservation practices have been shown to produce relatively low returns on investment (Ervin and Washburn 1981; Mueller et al. 1985; Napier and Forster 1982; Swanson et al. 1986). Returns on investments, when they do occur, are often not received until future years, and a large proportion of land operators do not have the ability to wait so long to receive a return.

Even though financial stress being experienced by many land operators is certain to impede volunteer adoption of soil erosion control practices, the CRP has the potential to off-set some of these negative impacts. It is highly likely that many land operators will be attracted to participate in the CRP by the guaranteed rents attached to participation (Agricultural Outlook 1986). It has been repeatedly demonstrated that farmers have adopted soil conservation practices when economic incentives have been offered as inducements (Bouwes and Lovejoy, 1980; Lovejoy et al. 1980; Napier and Forster, 1982).

The CRP requires the development of a conservation plan before farmers are permitted to enroll highly erosive land. Compliance with the CRP contractual agreements will result in the retirement of highly erosive enrolled land for a period of time and the use of soil conservation practices when it is returned to production or the land operator will be subject to penalty. The economic incentives associated with the CRP will attract many participants who would not have otherwise incorporated conservation practices into their farming.

While the conservation components of the 1985 FSA have the potential to increase farm income for land owners, they also may create problems for land operators who are renters. This is a potential adverse impact that must be recognized. In 1986, the bid price of land included in the CRP in certain areas of the country was almost one third of the total purchase price of the land (Agricultural Outlook 1986). Such rental levels will maintain the income of land owners, but will make it difficult for renters to compete in the land market.

Such high rents relative to purchase price also encourage investment by outside people, thereby exacerbating the socio-economic impacts on rural community groups as previously noted. If high rents are maintained by the CRP, many farmers and ranchers who operate rental land will be forced to leave agriculture for a period of time.

Another potential problem associated with the CRP is the inability of program participants to sell encumbered land unless new buyers agree to fulfill contractual agreements. Long-term CRP agreements provide participants with guaranteed payments, but they also may prevent financially stressed land operators from selling their land if such a need arises. Under present regulations, if a financially stressed farmer elects to sell his/her land to pay debtors while enrolled in the CRP, the new owner must agree to assume the responsibility for fulfilling the contract or the original owner will be required to return CRP payments received to the government. Such regulations are essential to ensure that contractual agreements are met, but they pose a potential problem for financially stressed land operators enrolled in the CRP.

Future Policy Considerations

While the conservation components of the 1985 FSA have the potential to significantly affect land management practices in the U.S., there is a major threat to their potential effectiveness. The threat is in the form of political pressure to change the objectives of the conservation programs. The conservation components of

the FSA were primarily designed as conservation programs with secondary impacts on commodity prices and maintenance of farm income. The financial situation in agriculture combined with national sentiments to reduce or eliminate commodity programs will create considerable agitation on the part of agricultural interests to find substitutes for the farm income maintenance programs. The conservation components of the FSA will undoubtedly be examined as replacements for commodity programs eliminated. Such a strategy, in my opinion, would be counter productive to national environmental goals and would not significantly reduce the impact of the farm financial crisis for farmers and ranchers most significantly affected.

It is quite possible that some narrowly focused agricultural interests will perceive CRP payments as having the potential to mitigate the loss of traditional farm income maintenance programs. Such perceptions are probably unrealistic because the magnitude of the farm financial problem is beyond the scope of the rents received for highly erosive land. The CRP will likely have only a minor effect at the national level in reducing the farm financial crisis, but should have a slightly higher influence in areas where there are many financially stressed farmers and ranchers operating marginal farm land. The CRP funds will have the effect of transfer payments in such communities.

Since CRP funding is targeted to highly erosive lands, it is unlikely that the limited funding will significantly reduce the high debt ratios of financially stressed land operators. The young, middle class farmers and ranchers, who are experiencing the most financial stress are not more heavily involved in the CRP than those who are financially stable, at least as it is presently organized.

Attempts to expand the CRP qualifications so that every financially stressed farmer and rancher can participate would defeat the purpose of removing highly erosive land from crop production. While attempts to make everyone eligible for the CRP may be politically expedient, targeting of limited resources can be defended from a variety of perspectives (Napier 1987). Economic and human resources are insufficient to remove all highly erodible land from crop production. If the additional objective of mitigating financial stress in agriculture is added to the CRP, the program simply will not achieve any of its specific goals.

Another reason for not changing existing goals and objectives of the conservation components of the 1985 FSA is the potential loss of political support of nonagricultural interests. If narrowly focused agricultural interests should be successful in changing the emphasis of these components from a program primarily designed to reduce soil erosion to an income enhancement program for land operators, it is quite possible that present nonfarm allies will become alienated.

Nonfarm allies are essential, if agriculture is to remain a viable industry in this society. Several interest groups were extremely important in the development and passage of the conservation components of the FSA and their goodwill must be maintained. Maximization of short-term benefits by narrowly focused agricultural interests could result in a significant loss of a political support base, thereby negatively affecting agricultural and natural resource policies for decades.

The policy decisions made in the near future concerning the conservation components of the FSA are extremely important in terms of the political future of agriculture and natural resource interests in this society. It is surely possible that political decisionmakers will approach the resolution of the farm financial situation from a politically expedient short-term perspective. If such an approach is used, the conservation components of the FSA may become nothing more than another farm income maintenance program. As a consequence, it would be highly unlikely that reduction of soil erosion or the reduction of financial stress in agriculture would be accomplished. The potential social impact of such a situation is the alienation of several significant nonagricultural publics that are significant actors in the policy arena. The loss of their political support would affect the allocation of resources to agricultural and rural development problems for a long period of time. Of all the possible adverse outcomes of the CRP, this would probably be the most costly in the long-run.

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Policy Questions from CRP in the Midwest

Jay A. Leitch[1]

Abstract.--Environmental policy development is both inherently difficult and difficult to model. The 1985 Food Security Act forced conservation policies to be developed and implemented in a short time and with little information. There are many areas where the Conservation Reserve Program (CRP) needs attention. CRP will substantially impact the Nation's pattern of cropland use, but it is not a long term solution to soil erosion problems. However, as problematic as the Conservation Title is, it is a big step in the right direction. While it is premature to draw profound conclusions, there is time for data collection, analysis, and course correction.

We are now in the early, formative years of a 10-year Conservation Reserve Program (CRP). Other papers in this Proceedings have addressed program specifics; however, this presentation deals with policy. Four issues are addressed; (1) policy in the 1985 Food Security Act, (2) environmental policy in a philosophical context, (3) policy issues regarding CRP implementation in the upper Midwest, (4) and a concluding section.

This paper relies on three sources. First is a series of papers presented at a NCR-111 workshop in June 1987.[2] Second, the published literature is beginning to grow with papers/reports on various aspects of the Conservation Title. They are cited as appropriate. Finally, I draw on my experiences observing policymaking at local, state, and federal levels, which causes me to be a bit skeptical and pragmatic.

Farm Bill Conservation Policy

The Conservation Title of the 1985 Food Security Act (FSA), some would say, represents the federal government's policy on conservation related to agricultural production. Federal legislation in general is purposefully vague and the CRP is no exception.

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[2]*North Central Regional Committee 111, Natural Resource Use and Environmental Policy Committee, was established in 1980 and is comprised of members from land grant universities in Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, Wisconsin, and the USDA. The members' universities and the Farm Foundation sponsored the workshop entitled, "The Conservation Title: What Have We Learned?" Six papers were presented on an overview, public education aspects, land owner participation, related state efforts, commodity specific effects, and policy challenges.*

While provisions, such as sodbuster and cross-compliance, have only recently been specifically articulated, economists, and others (e.g., range managers), have espoused such provisions for some time. The Congressional Office of Technology Assessment (1985), along with Congressional committee and staffers, helped Congress frame many of these provisions by providing the "objective information" of the public-choice policy model.

The FSA is an omnibus piece of legislation that provides a framework within which the Secretary of Agriculture is to administer its various programs. The Act gives the Secretary considerable discretion in implementing its provisions. A wholesale lack of information led most in Congress to the familiar cop out: "Let the Secretary decide." Bills are deliberately written to allow this discretion so lawmakers and the administration are not locked in to situations they may not foresee. It allows them flexibility to modify their policies or interpret acts to suit changing political climates. While legislators prefer vagueness to clarity, regulators, the federal agencies, need a certain degree of specificity and guidance to implement programs. Though flexibility should be a dominant characteristic of policy, it requires a clear statement of goals (Henderson et al. 1987).

Federal regulations that appear to be extremely detailed, demanding, and intrusive, often end up looking like paper tigers when it comes time for implementation and enforcement. While the general objectives of a program may be popular, soil conservation for example, the threat or imposition of sanctions is not. These and similar ideas about environmental policy are developed by Beam (1983).

Thus, a hard and fast conservation policy is not set in the FSA, but rather a framework is provided, within which the administration can attempt to articulate and implement its policies.

The stated purpose of the FSA (in report language) is to provide, as far as it can be done in legislation of this kind, the basis

for an economic climate in which efficient American family farmers can survive the grim squeeze that has already driven too many of them to or close to the brink of ruin (99th Congress 1985).

While this sounds more like a social program than a conservation program, the Act does include the Conservation Title, not as a primary purpose, but rather as a consolation to the environmental community. Amidst growing public skepticism, and with an administration ideologically committed to removing government from the marketplace, agricultural interests had little choice but to compromise and give environmentalists room to push their agendas. PIK payments had caught the public's attention when North Dakota wheat farmers, California cotton farmers, and southern rice farmers received large government payments to not farm. Also, urban congressmen began to see the rising costs of the farm program competing for limited federal funds, and all citizens have begun to take note of off-site consequences of soil erosion. CRP, though, would achieve objectives of agriculture, the environmental community (Kovan et al. 1987), and hopefully deficit reduction by reducing commodity payments.

Environmental Policy

Policy is a slippery concept that appears easy to define until one tries to do it. Policy is an individual or group conclusion as to the role of government with respect to a particular problem or circumstance; in this case, agriculture and conservation. The public-policy decision process has been thoroughly explored. Many models drawn from varying perspectives and philosophical predilections have been developed.[3] Barrows and Carriker (1987) discussed the role of politics and the market with respect to how natural resources are allocated. They concluded that from a national perspective, there are few constraints on agricultural production; however, agriculture's future in specific areas is subject to many forces and interests.

The popular, yet naive, public-interest model, where technical experts provide objective information to decision makers who decide in the public interest, is as far from realistic policymaking. Randall's (1987) diffuse model of public-policy decisionmaking more aptly describes environmental policymaking. Four basic elements of Randall's model are:

* Conflicts may be resolved in many arenas (legislative, executive, judicial, and the marketplace).
* Individuals have diverse endowments and seek to maximize their own personal well-being, employing these endowments in the various policy arenas.
* Public decisionmakers also pursue their own self-interest, which may or may not coincide with institutional objectives.
* Public decisions are often not final (except for the irreversible destruction of some natural systems).

The diffuse model supports the contention that most policies evolve or just happen. Their development does not follow any particular, well-anticipated path. This seems especially true of policies coming out of Washington, D.C., where pluralism, reelection, and political self-interest drive many public policymakers. "The translation of values [public or the decisionmaker's] into public policy is what politics is about." (Knutsen et al. 1983)

Policies are necessary when science/economics cannot provide objective solutions to moral or value issues. Normative conclusions cannot be derived from positive premises alone (Randall 1987). Policy connotes decision and action by and for society. The question we should ask today is, "Who is society?"

Is it the Oklahoma panhandle? The upper Midwest? Or cattlemen? Of course not, but those are the special interests we hear about with respect to FSA sanctions. Hence, federal policy becomes special interest policy when it affects you, but what happens to Society's interests?

Upper Midwest CRP

Over one-third of 350 million acres of highly erodible cropland in the U.S. is in the Midwest. As of the last signup, CRP enrollment in Minnesota exceeded 1.5 million acres at a bid of $55.89 per acre; in Montana it exceeded 1.7 million acres (at $37.31), in North Dakota about 1.5 million acres (at $38.15), and in South Dakota more than 800,000 ac. are enrolled (at $39.08). These four states represent almost one-fourth (24 percent) of all lands enrolled thus far. In fact, total CRP acreage would equal the area of 25 counties in North Dakota, about half of that state. Some farm-level examples will help to highlight issues and questions.

A South Dakota farmer who is retired and never farmed under any farm program, put all of his land into the program at $27.87 an acre. He stated that the CRP is going to catch on like wildfire, and will be the only way to make any money. He estimated that 80% of the farmers can't do near as well on their own (Crumrine 1987). Does this sound like a socially efficient program?

A farmer from Perham, Minnesota enrolled 30 acres at $42.50 per acre and got more than he would have for rent. There are widespread examples of CRP payments exceeding local land rents and, while there may be valid economic arguments for this, it nevertheless puts pressure on local rental markets.

A Streeter, North Dakota, farmer who enrolled 465 acres at $30 an acre, said, "I'm of retirement age. Anytime I can get my land into a reserve program and get income, it suits me." Cash rent runs $15 to $20 per acre in his county.

A Canby, Minnesota, farmer observed that the CRP looks good for farmers, but not for business. "It will definitely affect Canby, ...Some businesses are quite upset." The $70 the government offers for reserve land looks awfully good beside the $40 an acre that cash rent brings.

[3] See, for example, Knutson et al. (1983) regarding agricultural and food policy and Randall (1987) regarding natural resource policy.

Some think the program is not fair, because in some areas the enrolled land is used for hunting. For example, a Barnesville, Minnesota, farmer placed 800 acres into CRP and is now operating a hunting preserve at $12 per pheasant (McEwen 1987). South Dakota farmers learned the value of hunting leases during the PIK years. Of course, Texas land owners have capitalized on hunting related income for years.

In Michigan, farmers were found to not understand the provisions of the conservation title (Purvis and Sorenson 1987). The most popular reasons for enrolling were to cover land payments, to have a guaranteed income, and to make good use of land that is not profitable to farm in today's market conditions. Problems with the CRP included inadequate staffing of local agency offices, extensive or complicated rules (although CRP was the best understood provision in the conservation title), unclear government directives, changing rules, and a perception that the program rewarded poor managers with no consideration for farmers who have used their land properly. This is not unique to Michigan, however.

Reinvest in Minnesota (RIM) (Payer and Hicks 1987) has a land conservation goal to encourage retiring marginal agricultural lands. The long range goal is to retire about 2.3 million acres to provide wildlife habitat and prevent soil erosion and water pollution. Payments in RIM were originally tied to CRP, but this resulted in large windfalls to landowners. Minnesota is now considering annual adjustment of rental rates and has moved from a 10-year to a 20-year contract. Lands eligible for RIM are selected based on low agricultural productivity and high erodibility. Minnesota's goal is to retire unproductive land, not to reduce federal commodity payments. RIM was sold to the Minnesota Legislature and the public as a wildlife enhancement program, but it also provides lump sum payments seen as a help to distressed farmers.

Policy Questions

There is a broad range of policy questions depending on one's perspective. But, since CRP is a federal program, this paper addresses policy from a federal perspective. Three federal policy perspectives with respect to CRP are by the administration, Congress, and the agencies.

The administration, or the executive branch, is concerned with the federal budget, which translates into ensuring there are limits on programs that cost federal dollars. Secondly, the current administration is concerned with getting the government out of agriculture. Other than these two broad policy prescriptions, the executive branch is content to let others concern themselves with details of implementation of a program that Congress initiated.

Congress, on the other hand, is concerned with getting reelected and, because of this, needs to listen to its constituents. Congress is thus concerned about the family farm, cattlemen, ornamental tree growers, the environment, and a plethora of other special interests. Congress is generally not concerned with the federal budget, unless it means having to raise taxes.

The agencies' (part of the executive branch) job is to implement laws that Congress enacts, within the policy guidelines of the administration. Federal agencies are mostly mission postured. Because of this mission orientation, different agencies sometimes work at cross purposes--one hindering or undoing the work of the other.

Agencies are concerned, then, with implementation policies--how to implement the provisions of the Conservation Title while staying within the administration's policy guidelines, yet while meeting the expectations of Congress. Agencies are concerned with the administration's wishes, but are also cognizant of Congressional budget power. Since much was left to the Secretary's discretion in the Conservation Title, many implementation questions needed/need to be answered (Dicks and Reichelderfer 1987):

Which land is eligible for CRP?
...on a regional basis?
...by crop history?
...based on erodibility?
...consistent with other FSA provisions?

How large should the bid pool be?
...regional?
...national?

What should be the bid selection criteria?
...minimize CRP outlays?
...maximize erosion reduction?
...minimize government commodity payments?
...minimize net cost per ton of erosion?

What uses should be allowed on CRP lands?
...concern with social efficiency?
...concern with effect on special interests?
...concern with year 11?

What will be the effect on commodity prices?

How will provisions be enforced?
...creative farm ownership?
...bad public image?

Along with this list of questions, as well as many others, come several concerns at the local and state level. For example, the effect on land rents has caused some concern because it disrupts local markets. In Minnesota, the CRP payment to rent ratio is well over 1.0.

Discussed elsewhere in these Proceedings is the effect on local economies. The first question should be, "Should the federal government be concerned about the economies of places or of people?" Obviously "they" were concerned about places, since one CRP provision was that no more than 25 percent of the cropland in a single county may be enrolled. Hence, this limit has been exceeded in more than 50 counties.

Is it an objective of the FSA to preserve "living museums" in the form of small towns across the Great Plains? If hardware and grocery stores depend on socially damaging uses of natural resources to survive, shouldn't those resources be released to be put to better use elsewhere in the economy? Finally, the millions

of dollars in CRP payments injected into rural economies is good for business, but out of whose pockets do these millions come from? Is more damage being done in other sectors of the economy than would have existed in lieu of these payments to agriculture?

Local governments that rely on property taxes for revenue may need to adjust to CRP. In many areas the "agricultural value" of land is its taxable value. CRP land has no agricultural value for 10 years.

How will agencies accustomed to being friends of agriculture adjust to being enforcers of some CRP provisions that are unpopular? Further, the Soil Conservation Service will need an additional 3,000 employees to fulfill this new role of enforcer.

Conclusions

Each of the four elements in Randall's (1987) model of policymaking can be seen at work in development and implementation of CRP policy. It has been neither smooth nor easy to get here, and much remains to be done. Broad legislation leaves programs dependent upon implementation policy.

Policy means choices. Not everyone is going to be happy. Most farmers are happy with CRP in principle; poor managers are happiest. Environmentalists are happy, for now. Farm input suppliers are not happy, except for grass seed dealers. Taxpayers are generally not well enough informed.

CRP will have a substantial impact on the Nation's pattern of cropland use; but it is neither a long term solution nor a stable basis for a conservation program, especially as long as we have a two- and six-year Congress. Further, a single, narrowly defined, national soil conservation policy does not work, but leads to resource use inefficiencies.

Market prices will be an important variable in what happens in year 11; however it is still too early to draw profound conclusions. We need to watch closely, maintain good records of what happens and, hopefully, there will be opportunities to fine tune CRP.

Some say we moved too fast on this one--before we had adequate information. As problematic as the Conservation Title is, it is a big step in the right direction. Let's make the most of this opportunity.

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The Role of Wildlife as an Economic Input into a Farming or Ranching Operation

Fred C. Bryant and Loren M. Smith[1]

Abstract.--The economic role of wildlife in Texas' farming and ranching operations varies from being the most important product to providing only supplemental income. The Conservation Reserve Program (CRP) offers High Plains and Rolling Plains farmers and ranchers an opportunity to enhance wildlife on their land and supplement their income. Management alternatives are offered to improve upland game and big game habitat under CRP guidelines.

"Like finding a bird nest on the ground" is the colloquial phrase generally used to describe stumbling into that golden opportunity. On the High and Rolling Plains of Texas, the Conservation Reserve Program (CRP) is the "bird nest" which can literally be feathered by ring-necked pheasants *(Phasianus colchicus)*, quail *(Callipepla squamata* and *Colinus virginianus)*, waterfowl, and lesser prairie chickens *(Tympanuchus pallidicinctus)*, all species representing potential economic returns to a sagging agricultural industry. What other program could offer a businessman cash for purposely not manufacturing one product, and provide potential revenue for another product whose output increases with only minor adjustments and inputs? This is how we view the economic role of wildlife in the CRP -- as an opportunity for farmers and ranchers to enhance wildlife populations on their land, and possibly their income.

Landowners in Texas, 98% of which is privately owned, have for some time recognized the importance of wildlife [primarily deer (*Odocoileus* spp.), quail, and wild turkey *(Meleagris gallopavo)*] in their farming and ranching operations. Even in the depressed economy today, landowners sell trespass rights to hunting sportsmen for as little as $0.50/ac to as high as $12-$15/ac. In some examples, the role of wildlife as an economic input has long since exceeded the net revenue generated by livestock or other cash crops. And for those who fear these landowners only exploit the wildlife resource, take heart, because many are plowing money right back into habitat enhancement programs. Some ranches are even beginning to hire full-time wildlife biologists along with, or instead of, ranch managers. To date, however, this is the exception and not the rule. In most instances, revenues from wildlife still just supplement farm and ranch incomes, a situation that will probably remain for some time to come.

The focus of this paper centers on the High and Rolling Plains of Texas, a region rich in farming and ranching heritage. On the High Plains, a semi-arid land of sub-irrigation and level topography, farming has provided the economic base of rural communities for the past 60 years, and should continue to do so for years to come. On the Rolling Plains, livestock play a more important role, but the area still is heavily farmed. The CRP offers farmers and ranchers a chance to set aside part of their farmed acreage, and do something for the wildlife resource and potentially supplement their income from hunting lease fees. Thus, the primary objective in this paper is to offer management alternatives to enhance wildlife under the CRP and to report a range of economic returns for the region described above.

Upland Game

Ring-necked Pheasants

On the High and Rolling Plains the CRP probably has the potential to benefit upland game species more than any other wildlife group. This is particularly true for ring-necked pheasants. The range of the ring-necked pheasant in west Texas is primarily restricted to the High Plains, which, as mentioned above, is also one of the most intensively cultivated regions in North America (Bolen 1982). Therefore, the CRP has the potential to greatly improve habitat in this region. Guthery et al. (1980) noted that, because of intensive farming, there are deficiencies

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in nesting and wintering cover for pheasants. Travel lanes are also limiting because there are few permanent idle areas and roadside vegetation is sparse due to clean farming techniques.

Currently, playas (shallow windblown depressions that retain water) form the most important nesting and wintering habitat for pheasants in the region. These playas produce 40% of the pheasant crop, yet account for less than 2% of the land area (Guthery et al. 1984). Nonetheless, playas are frequently burned and grazed by cattle which decreases their carrying capacity for pheasants during winter (Guthery et al. 1984). In addition, because heavy precipitation commonly occurs during peak nesting in May and June, nest losses from flooding of playa basins can be high. Therefore, the CRP can benefit pheasants by compensating for these most critical habitat needs.

Dense and tall grasses, such as switchgrass *(Panicum virgatum)*, with a mixture of forbs will create good winter and nesting cover. Forbs such as sweetclover (*Melilotus* spp.) and alfalfa are often recommended. After substantial litter accumulation in 4 to 5 years, burning of grass cover in late winter will improve nesting conditions (Schramm et al. 1987). Fires in spring are detrimental to nesting.

Food is generally not a limiting factor in most of the region because of the prevalence of corn and sorghum crops. If existing dense vegetation in a playa can be contracted under CRP as "permanent vegetative cover already established" pheasant habitat will be improved by preventing grazing and other potential alterations. Playas receiving seasonal water can have dense stands of cattail (*Typha* spp.), smartweed (*Polygonum* spp.), and summer cypress *(Kochia scoparia)*, which provide excellent habitat (Whiteside and Guthery 1983).

Establishment of woody vegetation by creating windbreaks or scattered clumps will further improve cover by meeting needs for summer loafing sites and protection from severe winter weather. A playa wintering area can be used by pheasants in a 0.7 mi radius (Whiteside and Guthery 1983).

A management plan following the above recommendation will increase pheasant numbers. The economic return from these practices to landowners on the Southern High Plains can be substantial and is only now beginning to reach its full potential. Although lease fees paid to landowners for pheasant hunting are known, the economic benefits to local communities from increased restaurant and motel use, for example, are not available. Community returns are thought to be significant however, because of the great influx of hunters.

Guthery et al. (1984) noted that, for those areas with the best pheasant populations, lease fees were $75/hunter for opening weekend, $50/hunter for the second weekend, and $25/hunter for the third weekend. Guthery et al. also listed potential lease fees for a section (640 ac.) of land that had varying habitat value. In areas of the High Plains with the highest pheasant populations, lease fees ranged from $600 to $4,500/section depending on the crops and winter cover available. Areas with lower pheasant populations range from $200 to $1,700/section.

Quail and Mourning Doves

Northern bobwhites and scaled quail occur on the High and Rolling Plains. Most habitat management centers around production of bobwhites because they are preferred more by hunters. Neither quail species occurs in high population levels where the area has been intensively cultivated. Therefore, quail populations are higher on the Rolling Plains than the High Plains. Cover planted for quail should not be as tall as that planted for pheasants, i.e., not exceeding 2 ft. in height. This should be planted in small blocks or strips because large dense stands of grass restrict optimum bobwhite production.

Planting of woody vegetation will benefit bobwhites (10-25% cover), but scaled quail require much less woody cover (Schramm et al. 1987). If shorter grasses planted for quail, such as sideoats grama *(Bouteloua curtipendula)* or little bluestem *(Schizachyrium scoparium)*, seed-producing forbs [i.e., Illinois bundleflower *(Desmanthus illinoensis)*, Maximillian sunflower *(Helianthus maximiliani)*, partridge pea *(Canavalia fasciculata)*] should be mixed in with the grass, to enhance quail habitat because food is often limiting (Schramm et al. 1987). Also, quail numbers can be increased through the recently approved "annual wildlife food plots" conservation practice used to improve the food base in large stands of grass. Although food plot establishment is not cost shared, annual rental payments are still provided by the government. Food plots should be long and narrow, situated perpendicular to the prevailing winds, and occupy less than 10% of the total acreage covered under the CRP agreement. Sunflowers or grain sorghum serve as good food plots. Prescribed burning (every 3-5 years) of grass stands in late winter is used to maintain optimum quail habitat by eliminating undesirable litter accumulations (Schramm et al. 1987).

Mourning doves *(Zenaida macroura)* will also benefit from annual wildlife food plots if there is some bare ground between rows to allow doves to feed. Nesting can be improved by providing windbreaks, shrubs, and trees. Shallow water areas as permitted under CRP, will also attract doves.

Most dove leases are on a day-lease basis in the Texas High and Rolling Plains. For the first few weeks of the season a fee of $25/hunter/day is common. After the first few weeks prices drop to $5-$20/hunter/day. Quail leases are generally conducted on the basis of larger land areas and, therefore, prices are charged on a per unit area basis. Average lease prices range from $0.50 to $2.50/ac. Areas that practice more intensive habitat management may receive more than $3/ac.

Lesser Prairie Chickens

Lesser prairie chickens have a very restricted range in west Texas; primarily in the Panhandle along the border with Oklahoma and on the western border with New Mexico (Jackson and DeArment 1963). Prairie chickens occupy those sandy soil types dominated by shinnery oak *(Quercus havardii)* and sand sagebrush *(Artemisia filifolia)*. Previously cultivated areas adja-

cent to current prairie chicken range that enter into CRP agreements should be planted to those native grasses that are adapted to sandy soils such as switchgrass, little bluestem, or sand bluestem *(Andropogon hallii)*. A mixture of forbs, such as Illinois bundleflower, partridge pea, or sweetclover, may improve food conditions (Schramm et al. 1987). Small annual food plots of grain sorghum may also elevate the food base.

Because the prairie chicken hunting season is only 2 days in Texas, the economic potential for hunting lease rights is low. Landowners commonly receive $25-$50/hunter/day for prairie chicken hunting. Prairie chickens often serve as an enticement on larger land leases for other wildlife, such as quail, and can improve the overall lease price.

Waterfowl

Over 1 million waterfowl may winter on the High and Rolling Plains (Buller 1964). Most waterfowl are concentrated on the 18,000 playa lakes in the region (Guthery and Bryant 1982); therefore, management for waterfowl is essentially management of playas. Because of fluctuating water levels, most playas contain vegetation that waterfowl prefer, e.g. smartweeds, cattail, barnyard grass *(Echinochloa crusgali)*, and, hence, the lower basin may be contracted under "permanent vegetation already established." This natural vegetation will generally attract waterfowl and planting in the lower portion of the playa basin is not recommended. Where water is much more ephemeral, it may be possible to provide a more permanent source of water for waterfowl under the conservation practice, "shallow water areas for wildlife." Although not thought of as an important breeding area, the playas can produce large numbers of birds (Rhodes 1978). To promote waterfowl nesting, it is recommended that grass-forb mixtures, as recommended for pheasants, be planted on the areas immediately surrounding playas.

Although the playas have vast numbers of waterfowl, the interest in waterfowl hunting in this part of Texas is low. Waterfowl hunting traditions have not become well established in the High Plains relative to the coastal and eastern areas of the state. Therefore, very few waterfowl leases presently exist and the economic potential is low compared to these other areas. Most hunting rights that are leased are done on a daily basis for only $10-$20/hunter. Leasing for waterfowl hunting rights, however, may be increasing as evidenced by hunter-guiding activity in the region.

Big Game

Several species of big game occur on the High and Rolling Plains. On the High Plains, mule deer *(Odocoileus hemionus)* and white-tailed deer *(O. virginianus)* are found along creeks, rivers, and dry arroyos, and along the escarpment between the High and Rolling Plains. Densities usually are low compared with other regions of Texas. Pronghorn *(Antilocapra americana)* occur in small herds all across the High Plains where intensive farming is absent. White-tailed deer are the dominant big game species of the Rolling Plains and can occur in fairly large numbers, but mule deer and pronghorn populations are spotty.

In all habitats across the High and Rolling Plains, brush cover probably limits distribution of deer and a weak food base acts to limit population size (Sowell et al. 1985), along with cover.

If CRP farmland is adjacent to or interspersed with known deer or pronghorn habitat, it could be planted to enhance big game habitat under CRP guidelines. Because food is limiting, plantings should be directed at supplementing seasonal nutrition needs. Sweet clover, sanfoin, alfalfa, Illinois bundleflower, and Engelman Daisy *(Engelmannia pinnatifida)* supplement spring and summer nutrition of big game. Because annual plantings are now allowable under the CRP (10% of total area only), grain sorghum can be planted each spring to enhance late summer/fall nutrition, while winter wheat and triticale could be planted in late summer each year to boost winter nutrition, (Wiggers et al. 1984, Bryant and Morrison 1985). Several shrubs also are available to stabilize the annual food base (Schramm et al. 1987).

Deer leases currently bring $2-$4/ac. in the Rolling Plains. Where populations are sparse in the High Plains, package hunts or buck permits are sold. Package hunts for mule deer currently range from $500 to $1,500; pronghorn permits bring $300-$600.

Summary and Research Needs

The potential economic return for landowners managing for wildlife on the High Plains is probably highest for ring-necked pheasants. On the Rolling Plains, quail and big game should receive high priorities for management. At present, the economic return relative to the CRP investment is lower for waterfowl and lesser prairie chickens.

Research is needed to determine the importance of recreational hunting on the local economy as a whole and not merely landowner benefits. Mitchell and Evans discuss this and other research needs in this Proceedings.

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The Role of the Conservation Reserve Program in Relation to Wildlife Enhancement, Wetlands and Adjacent Habitats in the Northern Great Plains

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Abstract.--The Conservation Reserve Program (CRP) will enhance wildlife populations of the Northern Great Plains by providing acreage increases in both quality and quantity of grassland and woodland habitats. One of the greatest benefits of the CRP will be the addition of grasslands in conjunction with the U.S. Fish and Wildlife Service's wetlands easement program on private lands. Recommendations are provided on the establishment, maintenance, and post-contract use of CRP grasslands.

For approximately the past 4,000 years the Northern Great Plains region has been dominated with perennial grasslands of one type or another complemented by woody draws, riverine woodlands, patches of shrublands, and millions of wetlands, often described as hydric grasslands. In less than 150 years, many of the natural plant communities in this region have been converted into croplands or other socio-economic uses to provide food, fiber, shelter, and transportation rights-of-way. Through time, thousands of wildlife species evolved and adapted to the perennial grassland habitats of the Northern Plains, but today the remaining wildlife survive in ever decreasing and disjunct habitats of perennial grassland.

It is no surprise then, that natural resource managers join with agriculturalists to support and provide guidelines for implementing a national agricultural program that returns large acreages of annual croplands back into perennial grasslands.

It would take several volumes to describe all of the assets and deficits of the Conservation Reserve Program (CRP) of the Food Security Act of 1985 to prairie wildlife in the Northern Plains region. For the purposes of this paper, attention is focused on the value of CRP grasslands in relation to wetlands and their associated wildlife, primarily migratory birds. Recommendations for the CRP acreages, including the post-contract period, are provided.

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WETLANDS PERSPECTIVE

Interior fresh-water wetlands in the Northern Plains provide many ecological and socio-economic values to the citizens of North America. Wetlands can enhance local and regional water quality and supply by acting as surplus nutrient traps, chemical sinks, groundwater recharge areas, flood water retention basins, livestock watering holes, and occasionally, reservoirs for irrigation water. Wetlands can also enhance the quality of our personal lives by providing us with surface water space, fish, wildlife, and the beauty of aquatic vegetation.

Wetlands in the Northern Plains region have been converted or lost to other uses at an alarming rate during the past 150 years (Shaw and Fredine 1956). Tiner (1984) estimated that less than 50% of the original wetlands in the region remain today. The combination of less perennial grassland and wetland areas has been attributed as, possibly, the most important factor contributing to the decline in continental waterfowl populations. The majority of the wetlands in the glaciated prairie pothole region of the Northern Plains occur east or north of the Missouri River in the Dakotas and Montana, in western Minnesota and Iowa, and in the rainwater basin area of Nebraska, where intensive annual

tillage occurs over broad areas. As a result, many of the remaining wetlands are left isolated by a considerable distance from any type of perennial grassland habitat, except for narrow strips of highway rights-of-way.

WETLANDS VALUES TO WILDLIFE

Prairie wetlands have long been valued as a critical habitat for migratory birds, fish, and furbearers in North America. Some studies have also identified their importance to other game species. In the upper midwest, wetlands with dense stands of emergent vegetation have been found to be an important winter covert for white-tailed deer *(Odocoileus virginianus)* (Rongstad and Tester 1969), (Sparrowe and Springer 1970). Wetlands have also been found to be a very important winter covert for ring-necked pheasants *(Phasianus colchicus)* in Iowa (Green 1938, McClure 1948, Nelson 1950, Lyon 1954, Sather-Blair and Linder 1980). Especially in drier years, wetlands also have been rated as a valuable source of cover and space for pheasant nesting and reproduction (Baxter 1972, Kuck et al. 1970).

All waterfowl species use wetlands at one time or another for nesting, breeding, feeding, resting, or as migration staging areas. Some waterfowl, e.g. canvasback *(Athytha valisineria)*, are totally dependent on wetlands for all of their life cycle needs, whereas others, e.g. mallards *(Anas platyrhynchos)*, are only partially dependent on wetlands for their life cycle needs; i.e., mallards, often nest and feed in either uplands or wetlands.

Less understood is the critical nature of prairie wetlands isolation to the migration patterns and survival of waterfowl, smaller passerine species and shorebirds. Banding studies have shown that many bird species follow traditional migration routes from year to year. This poses several important ecological questions, yet unanswered; e.g., do migratory passerines need a continuum of fairly closely associated wetlands to maintain or restore their energy fat reserves along their migration routes? Do migratory passerine species need wetlands in combination with adjacent grassland areas to provide part or all of their daily needs during the reproduction period?

The answers to these and other questions are further confounded by the fact that prairie wetlands are highly variable in size, depth, water chemistry quality, vegetation composition, location, and basin land use. These unknowns have made wetland preservation programs very complex and, so far, inadequate relative to the continuing wetland drainage rates and losses. This brings us to an all important question: "How can the CRP enhance wildlife and wildlife habitats in the Northern Plains?"

WETLANDS PRESERVATION

In the early 1900's it became apparent that wetlands preservation was necessary in order to maintain waterfowl and other wetland wildlife population levels. Enactment of the Migratory Bird Hunting Stamp (duck stamp) Act in 1934 provided some funds for wetland protection. Many of the National Wildlife Refuges in the Northern Plains were purchased during the 1930's. However, wetland drainage gained momentum during World War II and in the following years. Wetlands protection continued at a slower rate than the drainage acceleration. In 1958 the Migratory Bird Hunting Stamp Act was amended to enable the U.S. Fish and Wildlife Service (FWS) to begin more intensive wetland preservation via purchase and easement options in the prairie pothole region of North and South Dakota, Minnesota, Montana and Nebraska.

In 1961 the FWS Small Wetlands Acquisition Program (SWAP) was enhanced with the passage of the 1961 Wetland Loan Act. The Loan Act has been extended three times since 1968 and continues today. Since the beginning of SWAP, the FWS has acquired fee title to approximately 1/2 million acres of waterfowl habitat and has protected approximately 1.2 million wetland acres with easements, mainly with perpetual contracts, in the glaciated prairie pothole region of the Northern Plains.

The FWS's fee title acquisitions, commonly referred to as Waterfowl Production Areas (WPA's) contain both uplands and wetlands, whereas, the easements, with few exceptions, protect only wetlands. According to unpublished reports, approximately 18,000 individual basins totalling about 256,000 wetland acres were protected on refuges and WPA's in the five-state area. In comparison, if it is assumed that the average wetland equals one acre in size, about one million wetlands have been protected with FWS easements. In addition to the FWS's wetland preservation effort, all states in the prairie pothole region of the Northern Plains also have purchased some wetlands, and the USDA has sponsored the Water Bank Program which protects wetlands and provides adjacent herbaceous cover during 10-year contracts.

WILDLIFE BENEFITS EXPECTED FROM THE CRP DURING THE CONTRACT PERIOD

CRP Acreage in the Northern Great Plains

As of August 1987, approximately 5 million acres of perennial grasslands and between 3,000-4,000 ac. of trees have been contracted for establishment in the Northern Plains states of Nebraska, North Dakota, South Dakota and Montana. Some CRP grassland acres are expected to be established in nearly every county within the prairie pothole region of the Northern Plains. This type of geographic distribution of CRP grassland will ensure shorter distances among parcels of undisturbed habitat. Some counties already have more than 200 CRP contracts totalling more than 50,000 ac. This density and total area of grassland habitat in a county has the potential to greatly enhance wildlife production on a local basis and, to a lesser degree, on a flyway and national basis since migratory species will benefit.

Wildlife Benefits From CRP Trees

Wildlife, soil erosion, and water quality benefits from CRP lands are anticipated beginning with the first year of complete growth. However, benefits from tree plantings will take longer to develop than grass plantings because of their slower growth and maturity rate. Establishment of woody plantings on CRP lands will provide long-term ($\geq$ 20 years) benefits to several wildlife species in the Northern Plains. Such woody plantings provide winter cover for white-tailed deer, ring-necked pheasants, gray partridge *(Perdix perdix)*, and sharp-tailed grouse *(Tympanuchus phasianellus)* (Henderson 1984). They also provide year-long habitat for squirrels, cottontail rabbits, and white-tailed jackrabbits and summer nesting habitat for mourning doves *(Zenaida macroura)* and several species of passerines.

Wildlife Benefits Expected From CRP Grasslands

From 50% to 85% of the Northern Plains region is annually tilled for the production of grain and oil seed crops (Higgins 1977). CRP grassland plantings in this region will be represented by a wide array of seed mixtures ranging from warm-season native perennial grasses to cool-season introduced perennial grasses and legumes. The quantity and quality of CRP grasslands being established will be an enhancement to many species of resident and migratory wildlife.

Wildlife Production

Several studies have shown that these type grasslands are important to white-tailed deer and a large number of species of upland nesting birds ranging from ducks, gamebirds and shorebirds, to hawks, owls, and passerines (Duebbert and Lokemoen 1976 and 1977, Higgins et al. 1984, Kirsch et al. 1973, Klett et al. 1984). Duebbert and Kantrud (1974) have compared avian production between seeded perennial grasslands and annually-tilled croplands and showed that seeded perennial grasslands produced many more young birds than croplands. Furthermore, wildlife production from planted CRP grasslands can be enhanced even more with some type of predator removal or control (Duebbert and Kantrud 1974, Sargeant and Arnold 1984).

Bridging Isolated Wetlands

On the approximate 1.2 million wetland basins protected by FWS perpetual easements, unlike WPA's and National Wildlife Refuge lands, there is little or no provision for adjacent upland cover for nesting birds. Upland nesting ducks and shorebirds require a combination of wetland and upland grassland to be effective producers. CRP grasslands will help provide this missing habitat component close to thousands of acres of easement wetlands; hence, waterfowl production will be enhanced.

The FWS has recognized the overall importance of CRP grasslands to easement wetlands within the prairie pothole region, and have offered landowners with FWS easements on or immediately adjacent to their acreage a bonus payment of $5 per acre annually for the right to perform additional wildlife management operations on the CRP land. Examples of such operations include wetland restoration, placement of man-made nesting structures or predator removal.

Another positive benefit of having CRP grassland adjacent to wetlands is that the grassland will help impede soil erosion and pesticide movement into wetlands, which should improve water quality for groundwater recharge as well as wildlife.

Public Lands Benefits From the CRP

There is considerable concern in the Northern Plains about over-harvest of some species on small areas of public lands receiving too much public use (Jessen 1970). In other areas, increased recreational use of public lands is a by-product of restrictions on access to nearby private lands. The addition of CRP grasslands into much of this region will provide additional suitable undisturbed uplands for sportsmen if farmers allow public access on these lands.

Sportsman/Agency Benefits from the CRP

Obviously, the increase in grassland habitat from the CRP will result in a greater supply of wildlife for both consumptive and non-consumptive user groups. Any increase in user participation equates to socio-economic gains for both public and private enterprises including landowners. Unfortunately, fish and game agencies lack methods of accurately predicting the increases in wildlife production from land retirement programs like the CRP. In the Northern Plains, wildlife enhancement by the CRP will certainly exceed that of the USDA's Water Bank Program of the 1970's and 1980's, but probably not exceed that of the USDA's Soil Bank Program of the 1950's or the Cropland Adjustment Program of the 1960's.

The lesser prospects for wildlife populations enhancement during the CRP contract years stems, in part, from the present lack of abundant breeding populations, particularly of ring-necked pheasants and several species of prairie ducks whose regional and national populations are the lowest they have been in many years (USDI-CWS 1986).

PROBLEMS EXPECTED DURING THE CRP CONTRACT PERIOD

Age-Related Quality of CRP Grassland

In a five-state study in the Northern Plains, Higgins and Barker (1982) found that grasslands established with similar seed mixtures as being used in the CRP grasslands generally did not

maintain maximum structural qualities for more than 7 years. Their results showed that planted grasslands reached their maximum height and density during the 3rd to 5th growing seasons and thereafter reduced in these structural qualities. However, any overall quality reduction effects in CRP grassland plantings will likely be moderated by the sequential establishment of stands over a several year sign-up period.

Structural qualities of planted grasslands can be maintained for longer periods of time, and low quality, "sod bound" stands can be temporarily rejuvenated by periodic treatments with prescribed fire, mowing and haying, grazing, fertilization, or with aerating by shallow tillage (Higgins 1987, Duebbert et al. 1981). However, evidence (Higgins and Barker 1982) suggests that most CRP stands in the Northern Great Plains will not need any rejuvenation treatments during the 10-year contract period, and those that may, should only need one treatment during the 10-years and usually not until after the 6th growing season. Thus, we recommend against any sequence of annual treatments, but that any rejuvenation treatment be done in as short a time as possible. Much more research is needed on maintenance and rejuvenation methodologies relative to planted grasslands and the response of wildlife to these management practices.

Weed Problems

Noxious and problem weeds are expected to occur in CRP grasslands in the Northern Plains because of the perennial presence of seed banks. Higgins and Barker (1982) found that noxious and problem weeds occurred infrequently among grassland stands, but when they did occur the area affected was usually large on a per field basis. Negative aspects of noxious and problem weed control include reduction in nesting cover by mechanical control methods. Control of weeds with herbicides can reduce the compositional quality of grassland stands by decreasing the abundance of legumes and other naturally occurring forbs within or adjacent to grasslands receiving herbicide applications. The effects of herbicides on wetland flora, fauna and water quality are largely unknown.

POTENTIAL USES OF CRP GRASSLANDS IN POST-CONTRACT YEARS

The future uses, economic or otherwise, of CRP lands during post-contract years will be largely dependent on the conservation plan designed for each farm prior to January 1, 1995 and the net economic gains the landowner can expect to get from each parcel of land.

As outlined earlier, lands with some type of perennial grass and legume cover can sustain more wildlife than lands under conventional annual-tillage cropping systems. Thus, for the purposes of wildlife management, we recommend the continuance of perennial grass cover on CRP lands even in post-contract years.

There are many potential post-contract uses of CRP lands in the Northern Plains region, but they can be grouped into three general categories; supplemental, alternate management, and reinvestment. Supplemental uses are those that can be done in conjunction with other land management activities at little or no extra cost or effort to the landowner. Examples of supplemental uses of CRP grasslands include honey production and charging access fees for hunting and other recreational activities.

Alternate management uses of CRP grasslands will usually, but not always, require some extra cost and effort in order to provide a sustaining income return to the landowner. Examples of alternate management uses of CRP grasslands includes the production of hay or pasturage for livestock, grass seed, bird feed, and the establishment of shooting preserves or dude ranches that provide rural experiences for urban citizens. The latter two uses require major changes in both land and people management including significant investments in advertising and higher risk insurance.

Reinvestment uses of CRP grasslands generally requires no extra cost or effort by the landowner, but they may eliminate the acreage for red meat or grain production except in times of disaster or national emergency. Examples of reinvestment uses of CRP grasslands include a sequential lease of the same land into another land retirement program by the owner, the fee title purchase of the area by another person or group, or a long-term or perpetual easement of the land use rights by a person, a public conservation agency, or a private conservation organization.

SUMMARY AND RECOMMENDATIONS FOR THE CRP

The CRP program is expected to be very compatible with ongoing wildlife management activities in the Northern Plains, and particularly so in regard to the FWS's wetlands easement program. Few maintenance or management problems are expected with CRP grasslands after their establishment; however, there are some concerns about the future of CRP lands during post-contract years. The following recommendations are provided to address these concerns.

1. Standards for establishing and maintaining quality herbaceous cover during the CRP contract period should be followed. To avoid harm to nesting wildlife, weed control and other maintenance activities, if necessary, should be done mostly before April 20 or after August 1 in the Northern Plains region, and not on an annual basis.

2. There is a need for USDA to continue to work with landowners and tenants before their contracts expire to ensure the basic merits of the CRP are sustained beyond the contract period for the long-term good of soil and water quality protection and wildlife production.

3. Agencies should put mandatory standards in place for the type of cover that should be planted on contract areas and stick with them. In several instances, the initial lists of plant species recommended by a states' CRP steering committee were later compromised because of landowner complaints. In essence, the compromises often allow species that have little value for wildlife or forage to be planted because it is cheapest to buy and establish. Convincing farmers and ranchers that investing in quality seed of species that are site adapted and provide useful wildlife habitat should be a paramount educational goal.

4. We recommend that increased emphasis be given by USDA and other agencies to take the opportunity to restore currently drained wetlands in conjunction with the CRP. Restored wetlands can provide society with a multiple of recreation, economic, and functional values. Foremost among them is the capacity for wetland basins to retain potential downstream flood water.

5. Priority should be given to those uses of CRP grasslands that are most compatible with the original purposes for which the Program was established. In order to provide the long-term (> 10 years) benefits to society as a whole, there is also a need to continue to prevent CRP lands from eroding in the post-contract years, and to keep them providing long-term public benefits without excessive public costs.

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History and Economics of Farm Bill Legislation and the Impacts on Wildlife Management and Policies

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Abstract.--Land retirement has taken two forms, long-term (Soil Bank) and annual (set-aside). Long-term contracts require permanent vegetative cover, thus increasing pheasant populations and attracting nonresident hunters who stimulate state and local economies. Annual contracts with no vegetative cover are detrimental to pheasant populations and do not attract hunters or their monetary expenditures.

The Conservation Reserve Program (CRP), along with swampbuster, sodbuster, conservation compliance, conservation easements, debt restructuring and multi-year set-aside, in the Food Security Act (FSA) of 1985, represents the most radical departure in federal farm legislation in many decades. Even those who have devoted an entire career to bringing some degree of logic to commodity/conservation features of farm programs are surprised by this Act.

It is premature to celebrate accomplishments of the conservation provisions of the 1985 FSA, even though they have great potential for achieving public benefit. In fact, there is room for some apprehension. In my view, and others share a similar opinion, the U.S. Department of Agriculture (USDA) has a demonstrated record for failing to adequately capture fish, wildlife, soil conservation and water quality benefits under past farm programs. Attempts even now are underway to emasculate sodbuster, swampbuster and conservation compliance. Annual set-aside programs, in spite of multi-year contract authority, continue to degrade wildlife habitat and water quality and accelerate soil erosion.

At least for the present, implementation of CRP has been handled reasonably well with regards to wildlife benefits. However, some exceptions can be noted. The Missouri Department of Conservation has been trying to reverse state and local Agricultural Stabilization and Conservation Service (ASCS) rules that require CRP acres to be mowed annually as a weed control measure. The Wyoming Game and Fish Department's request to not allow monospecific plantings of crested wheatgrass has fallen on deaf ears.

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The ironic part about CRP is that it took so long to implement a land retirement program having some common sense. Certainly, long-term programs are not new. Under the 1936 Farm Act, a vegetative cover crop was required on land out of production. That program idled 43 million acres in 1941. The acreage idled between 1943 and 1953 never exceeded 6.4 million acres, and was devoted to production of legume seed.

The effect of long-term land retirement under the 1936 Act on established pheasant populations in the Midwest and Northern Plains was dramatic. Between 1936 and 1942, more than 12% of the Nation's cropland lay idle under a cover of protective vegetation. This expanse of safe nesting cover pushed already expanding pheasant populations even higher. The pheasant harvest exceeded 83 million birds in Iowa, Minnesota, Nebraska and North and South Dakota between 1940 and 1950 (Kimball et al. 1956).

Those same pheasant populations declined sharply as retired land went under the plow to meet wartime needs. This expansion of cropping also coincided with a technological revolution underway in agriculture. As advances in farm technology and intensive use of cropland continued following the war years, surplus commodities again plagued agriculture. Land retirement programs were again instituted. This time in the form of the Soil Bank's Acreage Reserve and Conservation Reserve.

The Soil Bank Acreage Reserve was used in 1956, 1957 and 1958, and required no cover. It peaked in 1957 with 21.4 million acres. In 1959, with no land in the Acreage Reserve, 22.5 million acres were in the Conservation Reserve. Soil Bank Conservation Reserve contracts were for 3 to 10 years and planted to a cover crop. The Conservation Reserve peaked at 28.5 million acres in 1961.

Throughout their range, pheasant populations began an almost immediate recovery. Pheasant responses to the Soil Bank's Conservation Reserve was typified in South Dakota (Dahlgren 1967). That state's pheasant population in the mid-50s ranged from 4 to 6 million birds, pre-hunting season. With 1.8 million acres in the Soil Bank under vegetative cover, pheasant numbers increased to 8 to 11 million birds.

The Soil Bank's long-term contracts had another positive effect on South Dakota. Aside from any conservation benefits, local and state economies were enhanced. The near doubling of pheasant numbers in South Dakota produced a dramatic increase in nonresident hunters -- from 20,000 pre-Soil Bank to 70,000 at its peak, a 250% increase (Erickson and Wiebe 1973). Each of these additional nonresident hunters spent an estimated $200 while in the state (Matson 1964). If, as economists claim, each new dollar circulates through the economy six times, nonresident hunters attracted by more pheasants as a result of Soil Bank cover annually generated $60 million in economic activity. This stimulus to the economy was an unexpected spin-off of a USDA program designed to curb agricultural surpluses.

Even as the Soil Bank operated at more than 28 million acres, surpluses continued to accumulate. But attitudes relative to land retirement methods were undergoing change in Congress. Many elected officials had received criticism for allegedly moving farmers off the land, and thus undermining local economies. The reasoning was that farmers who put their entire farms in the Soil Bank and moved to town no longer purchased agricultural equipment and supplies from local businesses.

Whether the allegations were true or not, Congress responded by enacting legislation that authorized the feed grain program in 1961 and the wheat program in 1962. Through these two programs, land was idled on an annual basis. With both programs operating in 1962, nearly 39 million acres were retired in addition to the approximately 26 million acres still in the Soil Bank. For practical purposes, the Soil Bank ended in 1970 with 53 million wheat and feed grain acres out of production.

Given the total amount of land out of crop production, one would have optimistically expected pheasants to have reached all-time highs. This was not the case. Despite USDA regulations and claims to the contrary, cover requirements, euphemistically termed conserving uses, were lax and seldom enforced. In fact, with 53 million acres of idled cropland in 1970, pheasant populations had fallen below their pre-Soil Bank level.

The situation again is clearly illustrated in South Dakota. In 1960 and after, no new Soil Bank contracts were available, and acreages began to decline from the high of 1.8 million acres. Pheasant numbers likewise began to fall rapidly, as did the number of nonresident hunters. By 1971 the Soil Bank, with its permanent cover, was history. South Dakota pheasant numbers were below 4 million birds--a 70% decline--and 50,000 nonresident hunters who had pumped millions into the economy failed to show up.

South Dakota still had more than 3.0 million acres of land out of crop production. However, annually retired land with no cover produces few pheasants. Field checks of 8,106 ac. under annual contracts in South Dakota showed that 65.4% had no cover and 4.1% were mowed (Dvorak 1971).

Concern for dramatic declines in pheasant numbers, even with massive land retirement programs in place, prompted a joint effort by 13 state fish and wildlife agencies to document on-the-ground conditions of annual set-aside acreage. Idled cropland on more than 3,500 farms was surveyed. Of the 121,000 ac. checked, 57% had no cover. Of the remaining 43%, half had a grass/legume cover seeded the previous year and half a newly planted cover crop, mostly late-seeded oats. Mowing, plowing and discing of set-aside cover began in June, and, by December, over 85% of the new or established seedings were eliminated (Berner 1984). Subsequent surveys produced similar results; i.e., land with marginal value to ground nesting birds.

The state fish and wildlife agencies, through a newly formed Farm Program Committee, brought the set-aside survey results to the attention of USDA on several occasions. Nonetheless, no changes to regulations on conserving uses of set-aside lands were made. The fact that annual programs allowed summer fallow and late seeding of cover and stimulated early destruction of cover was never corrected.

Frustrated by a perceived lack of action, the Farm Program Committee, now involving 29 states, took its case to Congress. They sought changes in land retirement practices through the 1973 Farm Bill, then under debate. That effort culminated in a provision authorizing the Secretary of Agriculture to enter into "multi-year" set-aside contracts (four years under the Act), cost share for establishing cover on multi-year set-aside lands, and purchase easements in floodplains, shorelines and aquatic areas.

In retrospect, implementations of the conservation features in the 1973 Farm Act were ineffective. A concurrent disappearance of crop surpluses led Secretary Butz to call upon farmers to plant from "fence row to fence row", Rasmussen (1982). Hence, little importance or funding by Congress was given to conservation provisions. This philosophy neatly meshed with a sudden expansion of commodity exports due to a weak U.S. dollar, an oil embargo and crop failures in a number of foreign countries. Land retirement--long or short term--became a non-option in Congress and the Administration.

The benefits of promoting extensive crop production, primarily for export, were ephemeral. A global recession, other nations becoming exporters of major agricultural commodities, and a stronger dollar caused exports to decline between 1981 and 1983. The result was a deepening financial crisis on U.S. farms. By 1983, American farmers were over $200 billion in debt (Sampson 1984). Congress' solution was the most costly commodity support program in history. The infamous Payment-in-Kind (PIK) program took 80 million acres out of production at a cost of $12 billion.

PIK was, at the same time, proclaimed as a great conservation achievement. There was a claimed 1.6 tons per acre or 20% reduction in soil erosion. From a different perspective, if soil loss on cropland with protective cover can approach zero, PIK achieved only 20% of its potential.

USDA likewise touted PIK for its wildlife benefits. State fish and wildlife agencies, however, had conducted their own field checks and reached different results. Their data showed that, of the 43 million PIK acres in the Midwest and Northern Plains, over 9 million were fallowed. Another 17.5 million acres with crop residue or volunteer plants were disced by mid-July. Fourteen million acres had a late, seeded cover crop that was destroyed early. Only 2.7 million acres, or 6%, had an established grass-legume cover crop of any wildlife value. USDA claims to the contrary, PIK provided the least wildlife benefits of any annual set-aside program.

The FSA of 1985 continued the Secretary's authority to use multi-year set-aside contracts. CRP, under present authority, is limited to 45 million acres. To date, nearly 23 million acres have been accepted, and there is good reason to assume that the 45 million acre goal will be reached. However, even with CRP fully operational, sufficient acreage will probably not be taken out of production to reduce excess commodity supply.

CRP has operated under several criteria relative to eligibility. Under the 3T criteria, nearly 70 million acres of highly erodible land are eligible. About 104 million acres qualify using 2T as the standard, and eligibility increases to 118 million acres using the erodibility index of 8 or greater. With CRP fully funded and operating at 45 million acres, 73 million acres of cropland meeting one or all of these criteria are still in production.

Annual set-aside acreage for wheat and feed grains were 36.5 million acres in 1986 and 43.6 million acres in 1987, the first two years of CRP sign up. USDA anticipates annual wheat and feed grain set-aside acreage to be above 40 million acres for 1988 even with additional CRP sign ups. No information is available on the number of highly erodible acres that might be set aside under annual contracts. But, given the fact that farmers enroll their poorer land in any retirement program, it is logical to assume that a significant portion of the annual set-aside land could be classed as highly erodible. By not using multi-year contracts, USDA continues to miss opportunities for capturing public benefits at no additional cost. Wildlife habitat and water quality continue to be degraded and soil erosion is accelerated on as many or more acres than are enhanced and protected by CRP.

Some improvement in erosion control and water quality should be possible on non-CRP highly erodible lands as they come under conservation compliance after 1990. The degree to which that is accomplished remains to be seen. At this time, attempts are underway to introduce so-called "economic reality." Economic reality translates to weakening the level of control. Even the most ideal level of control does not directly equate to wildlife benefits.

It is commonplace to grow continuous row crops on adequately treated land. Where terraces, for example, are used, even they are planted to the crop. From a wildlife standpoint, such fields are of no more value after treatment than before. On the other hand, the use of multi-year set-aside contracts, in addition to conservation compliance on highly erodible lands not in CRP, offer unlimited opportunities to enhance wildlife populations, and the local and state economies they can stimulate.

How pheasants in particular, and wildlife in general, benefit from CRP remains to be seen. No measurable results are documented at this time. The U. S. Fish and Wildlife Service's National Ecology Center and state fish and wildlife agencies presently are designing survey techniques to measure vegetative composition and responses of selected species.

For the 1986 and 1987 sign ups in Nebraska, for example, a smaller than desired number of CRP bids have been offered in better pheasant range. Since historically large pheasant populations have occurred on flatter, more productive land, this should not be surprising. However, large acreages of such cropland are still being retired under annual programs. This is further justification for a sensitively managed multi-year set-aside program in conjunction with CRP. The need is there and the resources available to do just that. All that is lacking is enlightened leadership in Washington, D.C.

Achieving CRP wildlife benefits depends almost entirely on the no haying or grazing provision. It also depends on very limited use of the authority to allow these uses in declared emergencies. Given state governors' propensity to declare emergencies to open state and federal wildlife areas to haying is good reason for concern over the misuse of this provision.

Another concern for realizing CRP's wildlife potential looms on the horizon. Soon after passage, some began to assert that "non-use" of CRP land was not in the program's best interest. As a way to reduce payments, attract more landowners to submit bids and keep CRP lands in grass following contract expiration, they advocate haying and grazing.

There is no evidence that the non-use provisions of CRP are a deterrent to bringing the full 45 million acres under contract within specified time frames. In fact, although the law permits enrollment of the full 45 million acres in any one of the five years the 1986-87 "not-less-than" acreage is well ahead of schedule. Even an expanded CRP program of 65 million acres appears attainable without haying and grazing incentives.

Those who advocate haying and grazing as a means of keeping CRP lands in grass after contracts expire espouse a less than adequate solution. According to the 1977 Resource Conservation Act assessment, 20 million acres of pasture are eroding in excess of 5 tons per acre per year, and 60% of the non-federal rangeland is in fair to poor condition. There is little reason to assume that CRP lands that remain in pasture or range at the end of the contract period will be treated any better. Such treatment would be legal since, if not used to grow crop, they would not be subject to conservation compliance regulations. They could be eroding at a higher rate than if cropped with an approved conservation plan. Forgoing wildlife values for 10 years in the hope that CRP land will eventually become an overgrazed pasture is a poor trade-off.

There is no evidence that haying or grazing during the 10-year CRP contract will promote the orderly transition of 45 million acres of highly erodible and to less intensive uses. Communities where haying and grazing are now dominate land uses are by no standard riding a wave of economic affluency.

Why should an additional 45 million acres of grass solve the problem? It is more realistic to assume that additional livestock will further depress already low prices. The same is true for additional dairy cattle that would be needed to use newly created pasture and hayland, unless one considers another federal dairy herd buyout as an economic stimulus.

That CRP land can be hayed or grazed and still provide wildlife benefits has no practical basis. There may be some rationale for manipulating vegetative cover once during a 10-year contract to retain vigor; however, landowners generally do not operate livestock enterprises on a one-in-ten year schedule. Once an annual access is provided, an economic vested interest immediately develops. If then withheld, the recipient pleads economic hardship, and the demand becomes manifested in political pressure that agencies seldom can withstand. In the process, wildlife values are sacrificed. Pheasants do not vote.

Wildlife populations that will be enhanced by non-use of CRP and multi-year set-aside offer more potential for diversifying and stimulating local economies than more haying and grazing. Minnesota predicts that fall pheasant populations would increase from 1 million birds in 1986 to 5 million in 2 to 3 years with multi-year set aside. With multi-year set-aside and CRP, pheasants would increase to 9 million in 5 to 7 years.

Experience has shown that pheasant population increases of the magnitude described will attract a significantly large number of resident and nonresident hunters. It likewise shows that hunters, particularly nonresidents, expend a considerable amount of money while pursuing their sport. The potential of tens of millions of dollars added to state and local economies far exceed those that would be generated by additional livestock on, or haying of, CRP lands.

An additional benefit of retaining CRP acreages in a non-use status is less tangible, but nevertheless real. A conservation coalition representing conservation districts, wildlife, forestry, land use, range and water played a key role in formulating the conservation/commodity provisions of the 1985 Food Security Act. It should be kept in mind, however, that it was an uneasy alliance. Wildlife and environmental interests especially had traditionally opposed agricultural programs because they habitually failed to provide fish, wildlife and environmental benefits. These interests had watched as small watershed projects and Agricultural Conservation Program practices that they initially supported became little more than drainage programs. If CRP, for whatever reason, becomes a haying and grazing program as some advocate, it is unlikely that another conservation alliance will emerge in the near future.

The FSA is a notable achievement, but it is only a beginning. The combined efforts of many diverse interests are still needed to insure its implementation and continue and expand it beyond present authorization. Any attempts to initiate economic uses for CRP to the detriment of public values or weaken the other conservation provisions provided for in the law will sever that important coalition. The losers will be this nation's fish, wildlife, soil and water resources.

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The Role of Trees and Shrubs as Economic Enterprises and Wildlife Habitat Development in the Great Plains

Philip Hoefer and Gerald F. Bratton[1]

Abstract.--The Conservation Reserve Program (CRP) provides a means for landowners to convert highly erodible crop land into permanent vegetation that will control soil loss. Trees and shrubs are an option in practices CP3, CP4, and CP5; tree planting, wildlife habitat, and field windbreaks, respectively. Overcoming stressful growing conditions and certain CRP regulations is necessary to make planting trees and shrubs an economic enterprise. Block tree plantings for commercial purposes is limited to on selected sites, but they have intrinsic indirect values. Field windbreak plantings are highly feasible and recommended. Wildlife habitat plantings may contain a mixture of trees, shrubs, and grasses to benefit wildlife. All of these plantings can have economic and aesthetic benefits continuing decades beyond the contract period.

There are two distinctly different aspects of the role of trees and shrubs in the Great Plains; (1) as economic enterprises and (2) in wildlife habitat development. Although they will be examined separately, first addressing the economic role of tree and shrub planting, both are strongly influenced by the Conservation Reserve Program (CRP), and will be discussed within the framework of this legislation.

Two points are raised when analyzing the role of trees and shrubs as economic enterprises. The first is that planting trees and shrubs is beneficial for the purpose of protecting soil from erosion. Second, there must be some present or future economic gain for farmers to practice this conservation technique. Both of these will be discussed, but, first, it is necessary to lay some groundwork clarifying CRP guidelines and climatic restrictions of growing woody vegetation in the Great Plains.

CRP Regulations for Tree Planting

When the original CRP guidelines were distributed, several aspects relating to tree planting became apparent. Several of these are covered in other papers in these proceedings, e.g., reducing erosion, reducing surpluses of farm products, and subsidized base acres.

Close inspection of the CP3 tree planting practices reveals a clear intent to increase wood fiber production. Restrictions on CP3 and CP5 were regulated somewhat more than other practices. Opportunities for the production of Christmas trees, ornamental plants, fruit and nuts were eliminated. Some are legitimate and traditional forest products. Obviously, the lobby groups for these industries were against any future competition.

Although, nationally, tree planting for wood fiber production is a major stated goal of CRP, CP3 planting on the Great Plains is essentially limited to esthetic and recreational uses with limited opportunity for fuelwood or posts and poles. There are limited qualifying sites in the eastern portion of the Plains states where trees can be grown for wood fiber within an acceptable time frame, but most of these sites do not qualify under present soil loss tolerance restrictions.

A recent national decision by the Agricultural Stabilization and Conservation Service (ASCS) limits actual cost share payments for trees to $150.00 per acre, essentially eliminating CP3 in the more arid regions of the Great Plains. No allowance is made for the cost of special water management, such as drip

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irrigation systems necessary for proper tree establishment in these arid areas.

Plains Growing Conditions

Other papers presented in this Proceedings give details on the harsh climate and soils of the Great Plains. Such environmental conditions require special techniques for establishing and growing trees.

The eastern Great Plains vary considerably from the western plains. Precipitation averages near 40 in. in southeast Kansas, but declines to 12 in. or less near Colorado's Front Range. This is the major factor influencing growing conditions. The large variety of highly erodible land, blow sand to clay, also limits tree growth and establishment.

Role of CP3 Tree Planting

Tree planting in the Great Plains obviously involves different production goals from those of the southeastern United States. Commercial production of wood products is limited. When incorporating CP3 in the western Plains, more consideration should be given for esthetic recreation or possible fuelwood potential. Fuelwood planting in this harsh environment could yield 28 cord/acre but it might take 30-40 years to produce it.

Red cedar is another potential product showing increasing promise in the Great Plains. Markets for cedar include lumber for furniture, paneling, curio items, as well as posts and split rails. Acreages of eastern red cedar in Nebraska and Kansas have quadrupled within the last 20 years, and foresters are finding new markets for red cedar logs. Some are being exported to South Korea and Japan at this time.

Other values are associated with planting trees on the Plains. Farms and ranches with healthy windbreaks usually demand a higher sale price much the same way as a well landscaped urban residential property. Still, tree planting in the western plains often costs more to establish and maintain than can be returned over time. Supplemental irrigation is the major expense that takes the cost beyond a viable enterprise for most landowners.

For example, a $1.00 initial investment banked and compounded monthly at 8% will yield $2.21 in 10 years. Given the average Colorado tree planting installation cost of $2.50 per tree, that investment should be worth $5.50 at the end of 10 years in order to be "economical." This does not take into account the $.50 per tree estimated annual maintenance cost. To date, the best return realized is about $4.70 per tree unless trees are sold for ornamental purposes.

Role of CP5 Field Windbreaks

Field windbreaks are linear plantings of trees and shrubs designed to reduce the effects of wind on adjacent soils and crops. Wind erosion is proportional to the unsheltered distance across a field. Windbreaks interrupt that distance and reduce the erosion potential depending on the distance from the barrier in relation to the barrier height. In the western Plains, a tree barrier can be expected to attain a height of 30-50 ft. and be effective for several decades.

Tree windbreaks have a downwind effect in excess of 15 times their height. Therefore, a windbreak attaining a height of 40 feet would have an influence on soil erosion and crop protection for a distance of at least 600 feet.

But windbreaks will not solve the immediate problem being addressed by CRP on erodible lands. The purpose of this practice in the Plains should be to plant windbreaks in conjunction with grasses. A properly designed, installed, and maintained windbreak could bring the downwind field within soil loss limits and be approved for cultivation at the end of the 10-year contract period. As an added benefit, years of studies have shown increases in crop yields resulting from windbreak protection.

Livestock protection is another potential benefit from windbreaks planted in association with grass. The Montana Experiment Station found that livestock gained an additional 35 lb. during mild winters and lost 10 lb. less during severe winters when protected areas were available. Grasslands planned for grazing could have effective winter protection available at the end of the 10-year contract if they would incorporate windbreaks at the inception of a CRP project.

Before addressing the wildlife aspects of planting trees and shrubs, it is important to mention esthetics. There are numerous things that can be done to improve the quality of our living conditions with little or no regard to cost. Air-conditioning in automobiles or farm tractors cannot pay for themselves except in the comfort they provide. Additions to or remodeling of our homes often do not result in higher selling prices. These things are done in order to have a more pleasant environment in which to live. In the same manner, planting trees for woodlots, windbreaks, wildlife habitat, or just to improve the beauty of the countryside improves the quality of living that we, and more importantly, future generations will enjoy. As Aldo Leopold so aptly said, "What we do to the land is like putting a signature to it and I want my signature to be pleasing."

Economic Role of Wildlife Habitat Development in the CRP

The wildlife habitat improvement aspect of the CRP has not received nearly as much attention as it deserves and has the potential to fill a large economic void in the Great Plains region. The CP4 provision allows establishment of quality wildlife habitat including trees, grasses, and shrubs to furnish food, cover, and nesting sites. There are fewer restrictions than for most other CRP practices, and the plantings can include any permanent vegetation that is suitable for use by various wildlife populations. Several state wildlife departments are offering to help defray the landowner's share of expenses if specialized

plantings are used. For example, Colorado will cost-share up to $2,000 if a specially designed wildlife habitat is installed.

In many cases these habitats create an "oasis effect," islands of high quality cover surrounded by cultivated farm ground or seas of grass. These islands have great potential for upland game and big game population expansion. Many of the CP1 lands, although not primarily planted for wildlife, do much to improve habitat. However, they could better serve wildlife had trees and shrubs been included in the project. Small strategically placed plantings of woody vegetation could expand the wildlife capability considerably. To meet the national goal of one-eighth of all CRP lands in trees and to meet more optimal habitat design standards, many more CP1 (native grass) and CP2 (introduced grass) projects should have included trees and shrubs where possible. Not only would this have allowed for a wider variety of both game and nongame species, but it may have provided stability to the permanence of a program that could possibly end up being a huge 10-year farm land leasing project.

A recent survey made in Kansas, Nebraska, Colorado, Wyoming, and South Dakota, showed that many landowners presently plan to return their CRP lands to crops at the end of their contract period.

Many landowners are not aware of the conservation compliance part of the program or do not believe present rules will be enforced in the future. It's simple logic. A landowner is not nearly as liable to "doze" out a stand of trees as he is to plow up a stand of grass. The trees and shrubs will increase the longevity of the CRP practice by making it more permanent.

The positive aspects of planting plant materials for wildlife are often overlooked. What is the dollar value of viewing a white-tailed deer feed along the edge of a windbreak? What value can be attached to watching or filming a rooster pheasant strut through his mating ritual? What price can we place on the song of a lark sparrow that is attracted to the edge of our prairie oasis? These questions are difficult to answer, nevertheless a value is still there.

There are economic values we can place on some wildlife. The meat value of wild game harvested by hunters runs into the millions of dollars and is a direct benefit to the consumer. The landowner may benefit by charging a daily hunting fee or design a lease arrangement for hunters wishing to harvest the wildlife crop from his or her land. One economic value often overlooked is the money generated by the influx of hunters into a region because of hunting opportunities. These dollars could be substantially increased by the CRP as wildlife populations, especially upland game birds, increase.

Kansas game managers report that, in 1986, 293,000 hunters spent in excess of $55 million within the state, or $161 per hunter. A 10% increase in hunter use as a direct result of CRP increased habitat was considered very conservative. A 10% increase would generate $5.5 million per year in added revenue to the state, primarily from the purchase of goods, fuel, and lodging. A 600% roll-over effect will increase this amount to $33 million. Kansas officials envisioned that a more realistic increase might have been 20-25%.

There is a parallel analogy trend which might reflect the potential for increased hunting. In 1976, pheasant hunters numbered 145,000 in Kansas. This was during the time of soaring fuel prices which led to less field cultivation and, consequently, more available food and cover for upland game birds. The result was a mild pheasant population explosion and, by 1982, the number of pheasant hunters had increased to 196,000. This 35% increase in hunter use was caused in part by merely letting weeds grow and crop residue remain in the field a little longer. Therefore, the predicted 10% increase may indeed be conservative.

Nebraska reports 445,000 hunters spend about $90 million in their state. This amounts to approximately $200 per hunter. A conservative 10% increase would net Nebraska's economy nearly $9 million annually. With the 600% roll-over effect, $54 million would be generated.

The national average for dollars spent by an individual sportsman in pursuit of wild game is $490--considerably more than is presently spent in the Great Plains states. Hence, there is real potential to increase hunter participation and spending in this area by providing more and enhanced opportunities.

This is a small example of the economic potential due to the increase in habitat as a result of the CRP. It should be obvious that the wildlife dollar value is not one to be taken lightly.

Summary

1. There are measurable long-term economic advantages to increased wildlife habitat and tree planting. True conservation projects can rarely be tied to short-term production economics.

2. Not all benefits of forest and wildlife planting can be tied to hard dollar economics.

3. Many landowners and operators may not be aware of the conservation compliance portion of the 1985 Food Security Act, or they expect these rules to be changed or not enforced.

4. Trees and shrubs will add performance to the CRP.

5. Many conservationists are banking on the reaction of the public, to prevent conversion of CRP land back to cropland.

6. By strategically designing windbreaks within the CP1 portion of some sites, landowners should be able to meet compliance if they convert back to crops where conservation tillage alone will not qualify.

7. The regulations involved in CP3 appear to be unfair, do not enhance the initial reasons for developing the CRP, and actually prohibit much of the economic potential involved with forest production. Christmas tree and fruit and nut production should be

allowed in the Great Plains where competing industries presently do not exist.

8. The Great Plains is a unique area with needs unusual to the rest of the nation. The CRP needs more regionalized regulations in order to meet special climatic soils and even socioeconomic conditions. It is unrealistic to set standards for the south and expect them to fit the same set of circumstances of the Great Plains.

CRP Symposium -- History of the Native Plant Seed Industry, September 17, 1987

Don Hijar[1]

The history of the native plant seed industry in the United States started when livestock were introduced in 1540 by the Spanish explorer, Coronado. However, it took until 1830, nearly 300 years later, before large numbers of cattle were introduced into the Great Plains. Large cattle ranges, backed by foreign investors, took advantage of the open range.

Trappers and miners returned to the East with stories of a land of plenty. This started the great movement of the settlers to the West. To further promote settlement of the West, the government enacted the Homestead Act of 1862. This act allowed someone to claim 160 acres for a homestead with the provision that 40 of those acres had to be cultivated. In the Western Plains, the land often was not suitable for farming. A common practice was to farm 40 acres until its productivity declined, abandon that 40 acres, and break out another 40 acres of the homestead.

More grassland was plowed out during the later 1920s and early 1930s because of higher wheat prices. These higher prices were created by the demand during World War I. Because of the above average rainfall from 1927 to 1932, even more grassland was put into cropland. As a result, more cattle grazed fewer acres. This did not present a problem at the time, as the rangeland produced more forage due to the increased rainfall.

The stage was set for the worst period in agriculture's history. From 1932 to 1939, the Great Plains experienced a severe drought. Those 7 years were hotter, drier, and windier than ever recorded. Too many cattle on too few acres caused severe overgrazing. Many acres of cropland had been abandoned and had very little cover. Both cropland and rangeland suffered high soil losses due to the winds, causing the great black blizzards of the 1930s.

The economy was bad and the land was eroding tremendously. Something had to be done. Hugh Hammond Bennett, the father of Soil Conservation, pressed for an agency that could help the farmer control erosion. In 1935, the Soil Conservation Service was established.

The federal government developed a subsidy program to assist the failing farmers in getting through the depression and to cost share on recommended conservation practices. Conservation practices to treat the cropland were developed. The practice of re-seeding was developed to tie down the soil and to return this land to its most stable condition -- "native grass."

As early as 1895, there were grass planting experiments, but they were largely failures. For the next 35 years, few studies on range seedings were conducted. Not until the need arose, as a result of the Dust Bowl days, did interest resume in seeding native lands. The native plant seed industry started at that point of necessity.

The period from 1935 to 1945, was most important for the seed industry, even though few acres were seeded. During this period, we learned how to harvest, process, and plant native grass seed.

Most of the principal seed companies involved in the present Conservation Reserve Program (CRP) had their beginnings during the Soil Bank days of 1957 to 1961. The Soil Bank program, similar to today's CRP, was enacted to stabilize commodity prices by reducing the acreages in cropland and to control erosion on cropland.

There were only three principal companies involved in warm season native grasses during the Soil Bank era: Rudy-Patrick, Kansas City, Missouri; Johnston Seed Co., Enid, Oklahoma; and Miller Seed Co., Nebraska. Other seed companies that began during that period were Garrison Seed Co., Hereford, Texas; Bamert Seed Co., Muleshoe, Texas; George Warner Seed Co., Hereford, Texas; Arkansas Valley Seed Co., Rocky Ford, Colorado; and Sharp Brothers Seed Co., Healy, Kansas.

During the Soil Bank era, most of the plant materials used were from wild harvest. Few varieties had been developed or released, and even fewer were under production for commercial use. Combines were used for harvesting, but the crop had to be somewhat damp to prevent shattering. The seed was harvested and put into large burlap bags out in the fields which were turned regularly to dry. Oftentimes, the core would spoil if the bags were not turned frequently or if the seed was packed too tightly.

Today, the combine is also used, but many companies are swathing the grass into windrows and allowing it to cure out in the field. The window is then picked up and run through the combine. This method requires less handling to dry the material.

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The areas seeded during the Soil Bank are essentially the same ones being seeded under the CRP today. The principal grasses used during the Soil Bank in the Great Plains were blue grama *(Bouteloua gracilis)*, sideoats grama *(B. curtipendula)*, and little bluestem *(Schizachyrium scoparius)*. Grasses of secondary importance were switchgrass *(Panicum virgatum)*, sand dropseed *(Sporobolus cryptandrus)*, and sand lovegrass *(Agropyron smithii)*. Today, under the CRP, the principal grasses are basically the same with the addition of western wheatgrass. We are using as many as 15 other native grasses now in the CRP that could be categorized as of secondary importance.

Probably some of the largest harvests of native grasses occurred during the Soil Bank era. One company reported a harvest in 1957 of approximately 700,000 lb. of western wheatgrass in northeastern Colorado. Few of those acres remain in grass today. The western wheatgrass yielded 300 lb. of seed per acre. This is similar to western wheat yields under irrigated production. It required 6 combines 3 to 4 weeks to harvest this seed. Since then, there has not been a harvest of western wheatgrass of this magnitude in northeastern Colorado. In 1987, approximately 200,000 lb. of native western wheat, or 1/3 of the western wheat harvested in 1957, was harvested in southeastern Colorado. This is considered an exceptional harvest of western wheat by today's standard for Colorado.

In 1956, one company harvested 1.5 million pounds of native blue grama -- the average pure live seed (PLS) percentage was 42%. In 1959, approximately 30,000 to 40,000 acres of blue grama were harvested on the Marfa Highlands of southwestern Texas. The average PLS was only 25%. Other harvests between 1956 and 1981 were small compared to the 1956 harvest. In 1981, the harvest was phenomenal and it compared to the 1956 harvest of 1.5 million lb. The average PLS was 46%, slightly better than the 1956 crop. The blue grama harvest of 1986 was small compared to the 1956 and 1981 harvests; the average PLS was less than 20%. In fact, much of the material contained less than 10% PLS.

In 1957, one million pounds of little bluestem was harvested near Abilene, Kansas by one seed company. It took 2 months to harvest, with 150 people sacking the seed and loading 89 semitrailers. That seed was all sold in one year. The little bluestem harvest of 1986, by comparison, produced approximately 2.5 million lb. and will be used for the next two to three years.

In the native plant seed industry, one must take advantage of seed crops when they are produced, because it may be 10 years or longer before another crop worth harvesting occurs. For example, in 1957, 250,000 lb. of native sideoats grama was harvested near Adams, Oklahoma, but the very next year that same area was covered with western wheatgrass.

Although some varieties of grass seed were released in the 1950s and 1960s, the technique to grow grass seed had not been fully developed. To grow grass seed varieties under dryland conditions was not economically feasible. Yields could not be predicted or controlled. A more dependable technique for producing seed was needed. The technique for growing varieties of grass under controlled production was developed between 1952 and 1961. This technique consists of irrigation, row planting, cultivation, fertilization, and weed and insect control.

The technique of growing warm season species under controlled production was mostly complete by the end of the Soil Bank era in 1961. Because of this, nearly all the seed used for the Soil Bank program was wild harvest. Growing seed agronomically can ensure that a harvest will occur every year for most species, except for very unusual weather conditions.

During the period between the Soil Bank and CRP, economics dictated that farming was more profitable than ranching. Rangeland was converted to cropland and the need to establish permanent pasture was drastically reduced. From 1961 to 1986, many of the companies that were involved in the native plant seed industry during the Soil Bank had to turn to other products to stay in business. Many of the Texas and New Mexico companies, for example, began producing hybrid grain sorghums. For the last 25 years, there have been few seed companies that could make a living solely on native warm season grass seed. The native plant seed industry could not rely on agriculture as a marketing outlet for native grass seed.

During these years the Nation adopted a new philosophy -- protect the environment. Consequently, the Environmental Protection Agency was created and such laws as the Mine Land Reclamation Act of 1973 was put into effect. Because of these types of environmental agencies and laws, a new demand for native plants developed.

This new demand was not just for native warm season grasses, as was the case during the great drought of the 1930s or during the Soil Bank program. The demand was for much greater species diversity -- not just reclaim the land, but reclaim it to its original plant community composition.

Although species diversity has been demanded by the environmentalist for reclamation projects, the Soil Conservation Service (SCS) is using the same basic species today for the CRP as was used during the Soil Bank. The old saying that, "The more things change the more they stay the same," must be true. Twenty-five years have passed since the Soil Bank program ended, and we are again using the same combines to harvest the same grasses. We are still planting with the same drills. The SCS is still using the same methods. And the farmer is wishing that he was still paying the same prices for grass seed. Maybe some things do change.

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Implications of Changes in the Regional Ecology of the Great Plains

Linda A. Joyce and Melvin D. Skold[1]

Abstract.--Environmental, ecological, and economical factors are shown to affect land use in the Great Plains. The most recent government-sponsored conservation program will induce another series of changes in the landscape of the Great Plains. However, other potential changes in the Great Plains may overshadow the impact of the Conservation Reserve Program.

Changes in land use have been driven by economics, demographics, and government policy. The most recent government-sponsored conservation program, the Conservation Reserve Program (CRP) established under the Food and Security Act of 1985 (FSA), could affect 20% of the Nation's cropland. Within the 10 Great Plains states, 29% of the total cropland area is eligible for CRP. As of the fifth signup in mid 1987, 12.9 million acres within the Great Plains have been accepted into the program (USDA ASCS 1987). There are many questions concerning the consequences of the CRP in the Great Plains and the Nation. Will the CRP meet the national goal of reducing soil erosion on cropland? In meeting this goal, what shifts in land use will occur within the Great Plains and how will this affect the regional ecology, and economy?

This paper evaluates the potential consequences of the CRP in the Great Plains by examining; (1) the landscape within which cropland acres are set, (2) the forces of land use change within the region, and (3) the interaction of CRP with other potential land use changes. Subregions in the Great Plains be defined herein as the Northern Plains of North and South Dakota, Nebraska, and Kansas; the Southern Plains of Oklahoma and Texas; and the Mountain states of Montana, Wyoming, Colorado, and New Mexico. These subregions are defined by data collection procedures and differ slightly from subregions defined elsewhere in this proceedings.

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The Great Plains Landscape

Environmental Variability

The variability of climate within the Great Plains affects the amount and type of vegetation on rangeland and pasture (Herbel and Baltensperger 1985, Moore and Lorenz 1985). Climatic events such as unpredictable rainfall, severe drought, and damaging hail influence agricultural land uses. Circumvention has been attempted with irrigation, alternative crops such as winter wheat, or grazing systems dependent upon spring through fall grazing only.

The influence that climatic variability has on land use can be examined using an index of forage production variability (Sala et al. 1988). This index is production in favorable years minus production in unfavorable years divided by the average (fig. 1). Thus, a value of 0.9 indicates that the range in production is almost as great as the mean, a highly variable system. As the value approaches zero, forage production becomes more predictable. Based on this index, forage production in the Northern Plains appears less variable than in the Southern Plains.

The spatial pattern of CRP signups reflects this pattern in climatic variability. CRP acres are densely clustered in the area of the greatest variability (corner of Colorado, Kansas, Texas and Oklahoma) and towards the southern part of the Great Plains (Reichenberger 1987). Enrollment in the Soil Bank program also showed a similar clustering of acres in the area of greatest variability (Reichenberger 1987). Thus, environmental vari-

ability coupled with government programs affects the landscape pattern of crop and pasture land use.

The Historical Landscape

Prior to European settlement, North American ecosystems were relatively unaltered by human impact, particularly when compared to the European landscape. The Great Plains climax vegetation types, as described by Stubbendieck in these proceedings, evolved within a complex set of relationships between plants, animals, and fire. While a complete description of these pre-settlement ecosystems would be valuable in determining the ecological balance without extensive or intensive human labor and capital input, only limited estimates of wildlife populations, primarily big game, exist. Large numbers of herbivores such as antelope and bison roamed the plains prior to 1830, when settlers first arrived. These big game numbers are highly speculative, but are of interest for comparison with contemporary numbers of the same species and with historical and contemporary numbers of domestic grazing animals.

Historical bison estimates range from 30 to 60 million (Wagner 1978). Seton (1929) placed historical numbers at 60 to 75 million for the entire western range of the buffalo. For this study, a conservative estimate of 30 million for the Great Plains portion of the buffalo range will be made. Buffalo numbers declined with the massive buffalo slaughter associated with the fur trade. By the 1900's, these herds had been seriously depleted. Seton (1929) reported an estimate of 14 million buffalo nationwide. We have used a value of 7.5 million for the Plains census in 1900.

The original range of antelope included most of Texas, Oklahoma, Kansas, all of Nebraska, North and South Dakota, and all states further west (Seton 1929). Seton estimated antelope density at 30 per square mile in the better half of their range (the Plains east of the Rockies and California). If their Great Plains range was approximately 1 million square miles, a density of 30 per square mile would result in a historical estimate of 30 million antelope. Numbers had dropped to an all time low in the early 1920's; e.g., Nelson's (1925) Bulletin reported 16,449 antelope for Great Plains states in 1922-1924. Since that time, antelope have been increasing.

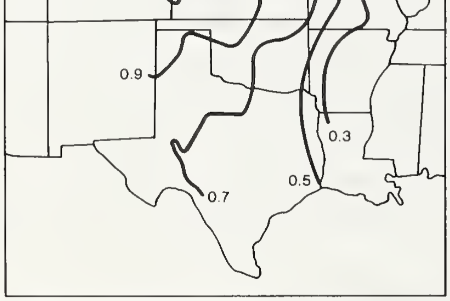

Figure 1.--Regional variability in forage production between favorable and unfavorable years in the Great Plains (after Sala et al. 1988). Variability estimated as (production favorable-production unfavorable)/average production.

Seton (1929) described the original range of mule deer covering the western edge of Texas and Oklahoma, half of Kansas, nearly all of Nebraska, all of North and South Dakota, and all states further west. He estimates that mule deer roamed this range at a density of 5 deer/square mile. Estimating approximately 800,000 square miles as the range, the deer population would be 4 million. Seton (1929) reported that white-tailed deer were absent from open plains and for this paper, their historical numbers were considered insignificant. However, recently, white-tailed deer have expanded westward along the riparian areas of the Great Plains, and have increased substantially in number.

Recent historical numbers for bison, mule deer, white-tailed deer, and antelope were obtained from U.S. Fish and Wildlife Service Big Game Survey, National Rifle Association Hunting annual survey, USDA Forest Service (1980), state fish and game annual reports, Council for Agricultural and Science Technology (CAST) (1986), U.S. Department of Agriculture 1939, and other data sources.[2]

To give a picture of the historical grazing pressure and for comparability across animal types, wildlife population numbers were converted to animal unit months (AUMs) using a method described by Wagner (1978). Wildlife numbers were reduced by the fraction of young likely to be found in them--40%. The remainder were treated as adults and used to estimate wildlife AUMs. AUM conversions were taken from Heady (1980): 1 Elk = 1 AUM; 5 Deer = 1 AUM; 5 Antelope = 1 AUM; Bison = 1 AUM. Because the grazing pressure of domestic livestock varies over the year, and wildlife remain on the land for the entire year, an annual estimate of grazing pressure was computed. All AUMs for native fauna were multiplied by 12. Nearly 300 million AUMS were supported on the Great Plains prior to the introduction of domestic livestock (fig. 2). Grazing pressure of native fauna has decreased, largely because animal numbers declined under severe hunting pressure in the 19th century (Schmidt and Gilbert 1978).

The initial movement of settlers west of the Mississippi coincided with the movement of livestock operators northward from Texas. The need for Confederate supplies briefly stimulated the western cattle industry, until the Union blockade. After the war, however, few cattle were found in the East, and economic incentives were great for the West to supply these eastern markets (Stoddart et al. 1975). By 1880, there were 10

[2]C. Flather, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO, Personal Communication.

million cattle and 10 million sheep in the Great Plains (fig. 3). These numbers grew over time, even with the continual conversion of rangeland to cropland. Horses and mules peaked around 1920 and declined thereafter with the advent of the tractor. Sheep numbers peaked and remained high between 1930 and 1945, but have declined since with decreasing per capita consumption of lamb and mutton and the advent of synthetic fabrics. Cattle numbers have risen consistently since the start of the beef industry.

Livestock numbers have been converted to AUMs, using the method described by Wagner (1978). AUM conversions were taken from Heady (1980): 5 Sheep = 1 AUM; 5 Goats = 1 AUM; 1 Horse = 1 AUM. Wagner (1978) assumed that, prior to 1940, cattle were finished on the range, not in feedlots. On the Great Plains, cattle would also have been finished on the range. Seasonal forage availability in the Great Plains may have been longer than in the intermountain region, thus we have taken 75% of the total numbers and multiplied by 12 to obtain an annual value for livestock AUMs. After 1940, Wagner (1978) assumed that irrigated pasture, cropland products, and feedlots were important. While pasture was important in the Great Plains, the amount of land in range, often good rangeland, is larger relative to the amount that could be found in the Intermountain West. Thus, we have calculated the highly speculative post-1940 cattle AUM's using half the numbers after 1940. Sheep and horses were assumed to be on the range 12 months.

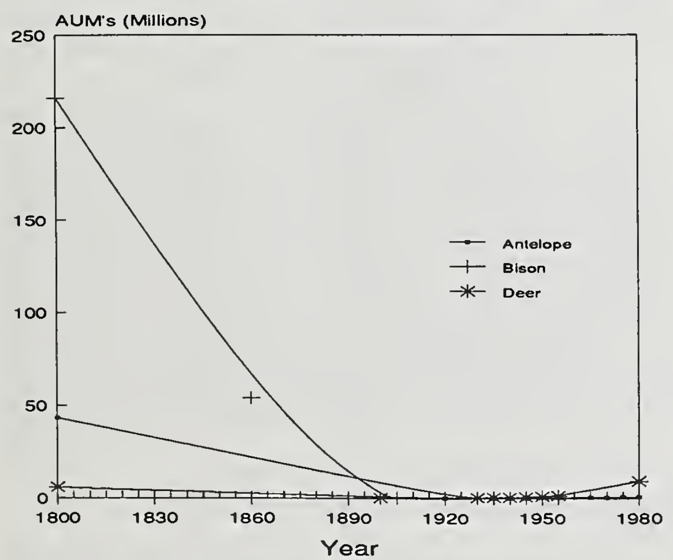

Figure 2.--Conjectured big game grazing pressure on the Great Plains region from 1900 to 1980. Wildlife population numbers from historical and recent inventories were converted to AUMs.

The inverse relationship between wild and domestic grazing pressure (fig. 4) does not infer a causal relationship between decreasing wildlife and increasing livestock, but rather that the early settlers and those who followed were a new ecological force that realigned the grazing influences already present. Wild grazers were replaced by domestic grazers, and wild browsers with domestic browsers (Stoddart et al. 1975). In the 1980's, domestic AUM's are above the pre-settlement wildlife AUM's. These wildlife AUMS were assumed to be in equilibrium with their original habitat. The current domestic AUM's are associated with only half of the original rangeland of the Great Plains, and are sustained only at considerable inputs of labor and capital. Any desired shifts in wildlife or livestock numbers will require a recognition of the needed inputs of land, labor, or capital to produce additional AUM's from the Great Plains system.

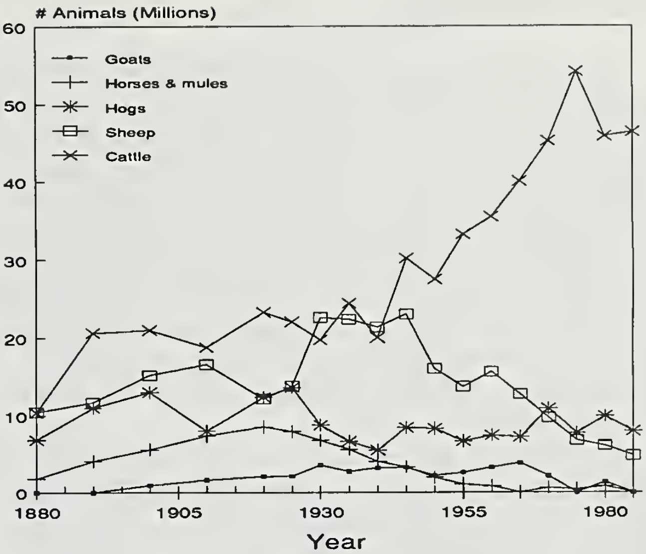

Figure 3.--Historical and recent numbers of domestic livestock on farms in the Great Plains region, 1880-1985. Data from U.S. Department of Agriculture (1982, 1986).

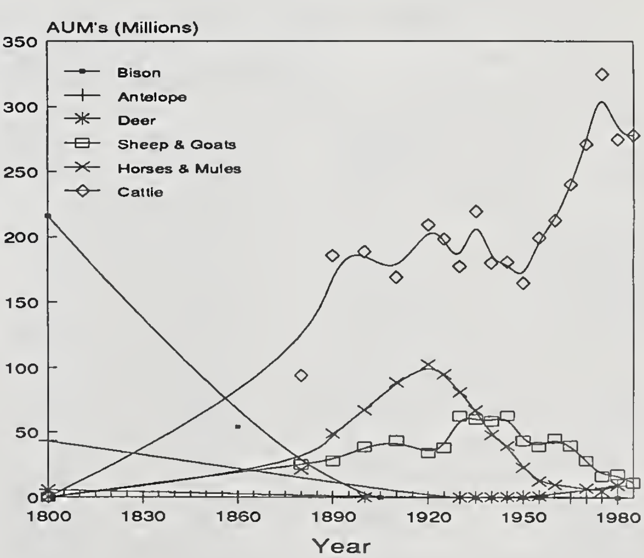

Figure 4.--Conjectured wildlife and domestic AUMs in the Great Plains region during 1800-1985. Domestic livestock numbers were converted to AUMs assuming cattle grazed rangeland only part of a year, sheep, goats, horses, mules, and wildlife grazed yearlong.

The Present Landscape

The current land use in the Great Plains is still dominated by range ecosystems (table 1). Cropland, range/pasture, and forest acreages have remained relatively static since the early 1900's (Frey and Hexem 1986). Within each of these major categories, the pattern of land use has changed. Crop plantings have shifted with economic demands and government programs. Within the past 30 years, wheat acres have seen major fluctuations; corn plantings have ranged from 10 to 20 million acres and soybean acres have increased four-fold (U.S. Department of Agriculture, 1986). Irrigation of cropland within the Great Plains has increased over the last 30 years, although this rate of increase has slowed recently.

The pattern of cropland used for crops[3] varies across the Great Plains (USDA Economic Research Service 1987). Within the Northern Plains, cropland has been used for crops with more constancy than other parts of the region (fig. 5). Within the Mountain states, the amount of cropland used for crops has been relatively constant, with a recent upward trend. Cropland used for crops remained within 12% of the base year 1977 for the Northern Plains and for the Mountain States. Within the Southern Plains, the index has ranged from 25% below to 13% above the base year 1977. This greater volatility in the Southern Plains, also seen in the forage index (fig. 1), is likely related to climatic variability and the resultant greater risks associated with farming. Government programs to reduce soil erosion and remove excess capacity from agricultural production have also been a factor.

[3]Cropland used for crops includes those acres on which crops were harvested, on which crops failed and cropland acres that were idled.

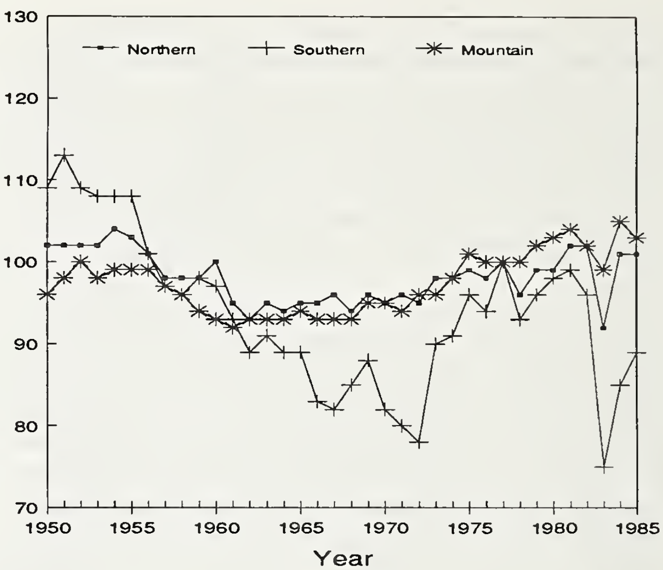

Figure 5.--Indices of cropland used for crops within the Northern Plains, Southern Plains, and Mountain states of the Great Plains. Base Year (index = 100) is 1977.

The 12.9 million acres already accepted into the CRP represent 8% of all cropland, or 1.8% of the total land base in the Great Plains (table 1). If relative regional contributions to the national CRP total remain the same, the number of CRP acres in the Great Plains potentially could increase to 20 million by the close of the program. The currently contracted CRP lands could double the number of acres in grass cover types, such as pasture, in Colorado and New Mexico, while the potential withdrawal could double these acres in Kansas and Montana (table 1). The impact of these changes will be a function of the resultant land

Table 1.--Total cropland, CRP eligible cropland, area for which cropland diversion bids are accepted, pasture, range and forestland, (1000 acres) for Great Plains States, 19871.

State	Cropland acres	CRP eligible acres	CRP acres accepted (% cropland)		Pasture acres	Range acres	Forest acres	CRP % of state
North Dakota	27,039	2,790	1,449	(7)	1,272	10,948	438	3.2
South Dakota	16,947	2,038	847	(5)	2,703	22,783	562	1.7
Nebraska	20,277	5,034	949	(5)	2,125	23,096	732	1.9
Kansas	29,118	7,032	1,980	(7)	2,241	16,909	626	3.8
Oklahoma	11,568	2,949	871	(8)	7,138	15,060	6,539	1.9
Texas	33,320	13,932	2,782	(8)	17,043	95,353	9,324	1.6
Montana	17,197	8,061	1,762	(10)	3,036	27,837	5,228	1.9
Wyoming	2,587	383	216	(8)	755	26,915	987	0.3
Colorado	10,603	5,469	1,584	(15)	1,250	24,222	4,030	2.4
New Mexico	2,413	872	455	(19)	163	40,982	4,734	0.6
Great Plains	171,069	49,100	12,895	(8)	37,726	357,894	33,200	1.8

[1]Land area data from 1982 SCS NRI (USDA SCS 1987); CRP data as of fifth signup (mid-1987) from USDA ASCS (1987).

use. For the duration of the contract period, these acres will represent idle land. After the contract period, uses such as grazing or a return to crop production can be considered.

The potential exists for the CRP to stem the changing composition of fauna on the Great Plains. Species historically associated with the Great Plains grasslands have declined in the face of trappers, market hunters, and the plow. Bison, white-tailed deer, elk, wild turkey, cougar, grey wolf, bear, and pronghorn antelope were exterminated, or radically diminished in population numbers (McConnell and Harmon 1976). While some species flourished under the new land use of agriculture, distributions of several wildlife species shifted from the intensive crop-producing regions of the Great Plains to areas where crop production was not the dominant land use.

Cropping pressures and fences in intensive livestock-producing areas have hastened the retreat of antelope into a smaller segment of its original range (Leopold et al. 1981). The sharp-tailed grouse has retreated north into Canada, leaving much of its original range in the Northern Plains (Leopold et al. 1981). Wild turkey distributions have moved south into the forested areas and west into the intermountain region, away from the large cropping areas of the Midwest (Leopold et al. 1981). Burrowing owl populations have declined largely as a result of widespread elimination of burrowing rodents, whose burrows are nesting sites for owls (Evan 1982). The long-billed curlew has been listed as one of 28 species nationwide to have unstable or decreasing population trends and the loss of short-grass prairie to agricultural development is the suspected cause of this decline (USDI Fish and Wildlife Service 1982). Intensive use of land for ranching or agricultural operations in southern Texas has been directly related to declines in the Rio Grande wild turkey (Gore 1973).

As rangeland has been converted to agricultural land, species such as quail, pheasant, rabbits, and with management, white-tailed deer, have increased. Breeding season densities of cowbirds, grackles, red-winged blackbirds, and starlings over the 1966-1976 period increased in the eastern Great Plains (Dolbeer and Stehn 1979). Baxter and Wolfe (1973) suggested that a threshold exists for agriculture and pheasant populations; below this threshold, an increase in cultivation results in an increase in pheasants; above the threshold, an increase in cultivation induces a decline in numbers. Harmon provides additional information on agricultural practices and pheasant populations in this proceedings.

The intensification of agriculture has transformed wildlife habitat in rural counties and states along the eastern edge of the Great Plains. A pattern of increased row crop plantings, decreased hay and small grain plantings, and decreases in wildlife populations has been described for prairie chickens, quail, rabbits (Vance 1976), and non-game birds (Graber and Graber 1983). This pattern of declining wildlife populations could be a prototype for other states (Karr 1981), but the increased permanent vegetative cover of CRP lands could stem this decline.

Land Use Changes

Population Growth--Urban versus Rural

Total population in the Great Plains increased from 17 million in 1950 to approximately 28 million in 1980. More importantly, this population growth occurred primarily in the urban areas, while rural population remained the same. Urban population grew from just under 10 million in 1950 to more than 20 million. This shift changes the services demanded by the population, and places different stresses on the environment.

When the population density, irrespective of urban/rural divisions, is examined, the Great Plains is much less densely populated than the national average of 64 people per square mile. This pattern is the result of the large amount of cropland and rangeland in the Great Plains. Important differences in density occur within the Great Plains. As one moves south, the population density increases. North and South Dakota have less than 10 people per square mile; Oklahoma and Texas have more than 30 people per square mile. Kansas, Nebraska and Colorado are in between these densities. Density and total population indicate where the potential for population and economic growth may be in the Great Plains.

Agricultural Industry

Intensification of production can be demonstrated for most crops over the 1950-1984 period (Skold and Young in press). The effect of technology on the dominant Great Plains crop of wheat can be examined in the annual changes in wheat production per acre. When annual per acre yield of wheat is regressed against time, a positive annual increase can be seen for each state, as well as the Great Plains region (table 2). This yield increase ranges from 0.36 to 0.65 bu/ac. per year across the states. The Great Plains increase was 0.54 bu/ac. per year. With a current wheat acreage of 46.9 million acres and a regional annual increase of 0.54 bu/ac., each year brings an additional 25.3 million bushels of wheat.[4]

Associated with this increasing trend, however, is a substantial year-to- year variability in yield. The semi-arid region experiences significant climatic fluctuations so that the coefficient of variation of annual wheat yields ranges from 20% to 38% (table 2). Consequently, when the coefficient of variation reflects a range of 7 bu/ac. around the yield mean, the 0.54 bu/ac. increase in the Great Plains annual wheat yield of 23.2 bushels per acre is easily missed. This variability makes it difficult to gauge the impact of land withdrawal programs on crop production levels.

Since the 1950s, programs have been implemented to control the supply of certain agricultural products. Acreage diversion programs have included both temporary diversions (1-year) and long-term (2- to 10-year) diversions. Long-term diversions, such as the Soil Bank of 1956 and the current CRP, require

Table 2.-- Average wheat yields, yield trends, and variability, Great Plains states (USDA Agricultural Statistics 1984).

State	1950-84 average (bu./ac.)	Coeff. of variation (1950-1984)	Ann. increase in yield (bu./ac.)	Std. error of annual increase
Colorado	22.1	31	0.49	0.08
Kansas	25.7	31	0.65	0.70
Montana	23.6	20	0.36	0.05
Nebraska	29.4	25	0.57	0.07
New Mexico	24.2	38	0.53	0.09
North Dakota	22.5	30	0.50	0.07
South Dakota	19.5	36	0.49	0.08
Oklahoma	22.8	33	0.60	0.07
Texas	20.1	34	0.55	0.06
Wyoming	23.3	24	0.38	0.07
Great Plains	23.2	30	0.54	0.05

**Based on regression analysis: y = ax + b where y = annual wheat yield; x = dummy variable for year; a = estimate of annual increase in yield. Results all significant at the 0.0001 level.*

withholding cropland from production for the term of a contract. Such idled cropland may or may not have been put to another agricultural use, as explained by Bedenbaugh in this Proceedings. The intent of cropland diversion programs is a decrease in the amount of cropland used for crops. The success of these programs can be examined in terms of the acres of cropland used for crops, or in terms of total crop production. Presumably, one acre diverted would result in one acre removed from cropland used for crops and a decline in the overall crop production of the region.

To determine what extent the increase in diverted acres correlated with a decrease in the amount of cropland used for crops, diverted acres for the 1956- 1985 period were regressed against cropland used for crops. One diverted acre, under both short- and long-term contracts, resulted in a less than one acre reduction in cropland used for crops: 0.33 acre in the Northern Plains, 0.55 acre in the Southern Plains, and 0.41 acre in the Mountain states (table 3). This less-than-one-for-one relationship between cropland diverted and cropland used for crops has been observed before; it has been termed the slippage factor (Ericksen 1976).

One of the reasons for slippage is that, as land diversion programs are implemented in the Great Plains, the proportion of crops planted on summer fallow increases. Summer fallow acres have been used to meet the program requirements for temporary diversions. The slippage from diverted acres into summer fallow provides an interesting mirror image of the cropland diversion programs. As acres are diverted, cropland used for crops (which includes cultivated summer fallow) decreases (table 3). The shift within the cropland used for crops category (from harvested

[4]Based on the regression analysis, this estimate has a standard error of 2.7 million bushels.

Table 3.--The effects of acres diverted on cropland used for crops, great plains, 1956-85 (USDA ERS 1987).

Region	Constant (1,000 ac.)	Change in cropland per acre diverted*	Standard error of change	R^2
Northern Plains	92,246	-.33	.05	.63
Southern Plains	37,762	-.55	.10	.53
Mountain States**	27,341	-.41	.10	.36

**Regression analysis: y = ax + b were y = cropland used for crops, x = diverted acres; a = estimate of the effect of diverted acres on cropland used for crop. Regressions significant at 0.0001 level.*

***Includes only the Great Plains portion of the Mountain region.*

cropland to cultivated summer fallow) is seen by the positive regression coefficients between diverted acres and summer fallow acres (table 4). Summer fallow plantings are affected by many factors other than diverted acres, as indicated by the variability captured in these regressions (table 4). The Southern Plains, where each diverted acre results in a 0.55 acre reduction in cropland used for crops, has the smallest slippage to summer fallow; each diverted acre is associated with a 0.11 acre increase in summer fallow. In the Northern Plains, a diverted acre reduces cropland used for crops by 0.33 acre while summer fallow increases by 0.27 acre. For the Mountain States, cropland used for crops falls by 0.41 acre for each diverted acre but summer fallow increases by 0.16 acre. Thus, the land diversion programs succeed in reducing total cropland used for crops, but at a less than one-for-one rate, because some of these acres return to cropland use as summer fallow.

The other measure of crop reduction programs is total crop production. Three forces operate to increase the output per acre of cropland remaining in production (not diverted); the remaining land is of overall better quality, higher proportions of the crops are planted on fallow land, and management compensates for reduced cropland. Presumably the least productive acres are diverted and some of the diverted acres end up as summer fallow.

Table 4.--The effects of acres diverted on summer fallow acres; Great Plains, 1956-85 (USDA ERS 1987).

Region	Constant (1,000 ac.)	Change in cropland per acre diverted*	Standard error of change	R^2
Northern Plains	13,153	0.27	.12	.15
Southern Plains	2,035	0.11	.03	.28
Mountain States**	9,667	0.16	.04	.41

**Regression analysis: y = ax + b where y = summer fallow acres, x = acres diverted. Regressions significant at 0.05 level for Northern Plains, and at the .01 level for Southern Plains and Mountain States.*

***Includes only the Great Plains portion of the Mountain region.*

Summer fallow yields tend to be greater than continuous cropped yields (Bond and Umberger 1979). Further, other inputs, notably fertilizer, may be substituted for land to increase production on land remaining in crops. While production should decline as cropland harvested is reduced, its decline is partially off-set by these output effects.

To determine the effect that acreage reduction programs have on the total crop production in the Great Plains, diverted acres of cropland and time were regressed against the index of crop production. The index of crop production incorporates the production of all crops in each subregion, including harvested hay. A measure of crop production more closely related to only those crops in acreage control programs would have been desirable; however, only the index of total crop production was available. Thus, for those regions where harvested hay acres are important, such as the Mountain States, the regression coefficients will be smaller than if a measure relating only acreage control crops were used. Time is included to account for the increasing yield trends observed earlier.

The small coefficients for the Southern Plains and Mountain States indicate a limited impact of diversion programs on crop production (table 5). Over the 1956-1985 period in the Southern Plains, each million acre increase in diverted acres is associated with a 1% decrease in the index of crop production (standard error of this coefficient was 0.05%). A million acre increase in diverted acres in the Mountain States is associated with a 2% percent decrease in the crop production index (standard error of this coefficient was 0.05%).

The results of these regression analyses indicate that the current CRP signup of approximately 3 million acres will be associated with only a 3% reduction in the crop production index in the Southern Plains. Approximately 3 million acres in the Mountain States will be associated with a 6% reduction. General cropland diversion programs are moderately effective in reducing the acreage harvested of crops; but, these programs have had limited effect on the reduction of crop output. Many other factors contribute to crop production in the Great Plains regions, notably climatic factors mentioned earlier in this paper.

Table 5.-- The effects of acres diverted and time on the index of crop production (1977=100) in the Great Plains, 1956-85 (USDA ERS 1987).

Region	Regression Coefficient for diverted acres[1]	Regression Coefficient for time	R^2
Northern Plains	-.0001*	2.41	.82
Southern Plains	-.001	.86	.49
Mountain States	-.002	1.58	.93

[1]*Regression analysis:* $y = ax + bz + c$ *where* y *= index of crop production (1977=100),* x *= diverted acres,* z *= dummy variable for time. Regression significant at the 0.01 level.*

*Not significant.

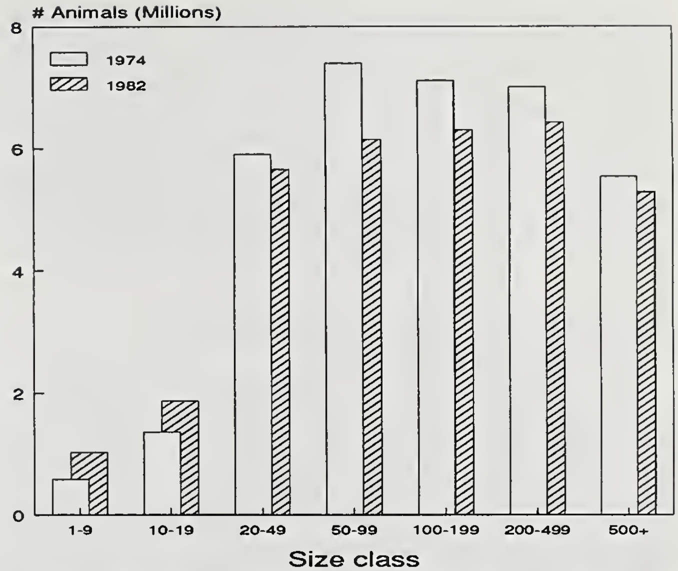

Figure 6.-- Number of beef cattle and calves by size of cow herd in the Great Plains for 1974 and 1982. Data from U.S. Department of Agriculture (1974, 1982). These numbers do not include 7.7 million steers in 1974 and 10 million steers in 1982.

Livestock Industry

Restructuring within and exits from the livestock industry affect the Great Plains economy. Recent concerns within the agricultural business community have been the agricultural credit crisis, and uncertainty about the future demand for red meat (Drabenstott and Duncan 1982, Fedkiw 1985). Pasture and rangeland, along with idle land, have been the most important sources for new cropland since 1975. During the 1975-1979 period, 64% of new cropland came from pasture, range, and idle land. During the 1979-1981 period, the number rose to 84% (Heimlich 1985).

Nationwide and within the Great Plains, the total number of farms has decreased and the size of the average farm has increased (Lagrone 1979). Average herd size of beef operations started to decline during the rapid reduction in beef cow numbers beginning in 1975 (Gilliam 1984). By 1978, the average beef cow-calf herd was 34 brood cows, and more than 58% of all herds contained fewer than 20 cows.

Changes in the number of farms and number of livestock over the 1974-1982 period reflect this overall decline. The number of livestock in herds of 20 or more animals has decreased. Within the smaller size classes, the total number of livestock has increased (fig. 6). Over the same period, no growth was seen in the number of farms with herds of greater than 20 animals (fig. 7). However, the number of farms in the small size classes increased from a little over 40,000 to nearly 80,000 farms. Similar results have been reported for Colorado where the state-wide increase in farms over the 1978-1982 period was the result solely of an increase in small farms, where small was defined as less than 179 acres (Miller et al. 1986). Farm numbers in all size classes over 179 acres declined.

The changes in beef farms by herd size class differed by state within the Great Plains. The number of small farms decreased from 1974 to 1982 in Nebraska but remained the same in the Northern Plains, and northern Mountain States. Over the same period, the number of small farms doubled in New Mexico and Oklahoma, and nearly doubled in Texas. Most of the beef was still produced on the larger farms. However, the landscape of the Southern Plains is becoming dotted with smaller size beef farms.

Government Programs and Land Use Change

National attention focused on the links between resource use, management, and soil erosion during and after the "Dust Bowl" of the 1930's. Fearing a similar circumstance in the 1950's, Congress gave recognition to the fragile environment and many acres of cropland were diverted in the Great Plains Conservation Program. An entire region was perceived in terms of its susceptibility to soil erosion. Responding to the higher commodity prices of the 1970's and encouragement by policy makers to plant, there was pressure for expansion and cropland acres increased. Here, the Great Plains region was perceived in terms of its potential to feed the world. While the concerns about the adequacy of the resource base to meet future demands resurfaced temporarily in the 1970's, recent attention has been on issues of excess capacity, resource conservation, and financially stressed farmers. These concerns affect policy that shifts labor and capital inputs within and to a region.

The regional variability in land and soil type affects the national distribution of government programs aimed at reducing crop surpluses or soil erosion. Of the 83.3 million acres of highly erosive cropland, 39.9 million acres or 48% of it lies in the 10 Great Plains States (Skold and Young in press). The three

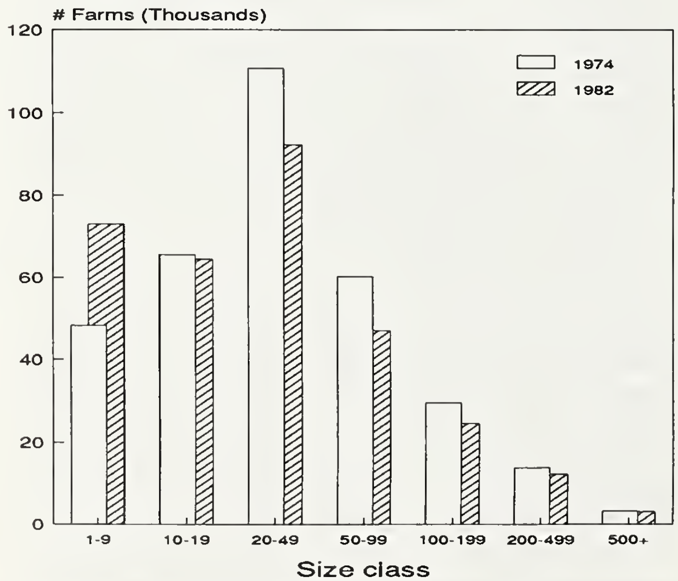

Figure 7.-- Number of beef farms in the Great Plains by size of cow herd for 1974 and 1982. Data from U.S. Department of Agriculture (1974, 1982).

Table 6.-- Distribution of reductions in program crops depending on implementation strategy, Great Plains (Grano et al. 1985).

Strategy	Percent reduction in program crops in: Northern Plains	Southern Plains	Mountain States
Retire least profitable land	18.5	35.9	6.2
Retire least profitable land with past diversion patterns	38.3	17.9	12.2
Retire targeted erodible acres	27.2	9.0	11.2
Retire only highly erosive land	7.4	1.3	1.2
Retire highly erosive land prioritized by erodibility	8.1	1.4	1.3

subregions within the Great Plains contain about 44% of the Nation's cropland. About 37% of the land converted to new cropland during 1975-1977 and 1979-1981 was located in the Great Plains: 14% in the Northern Plains, 11% in the Southern Plains, and 12% in the Mountain States (Heimlich 1985). Of the converted land deemed highly erodible, 17, 11, and 21% of it is in the Northern Plains, Southern Plains, and Mountain regions, respectively (Heimlich 1985). The newly converted land is more erosive than former cropland. Thus, the Great Plains has contributed a less-than-proportionate share of the new cropland but a greater-than-proportionate share of highly erosive cropland.

Different strategies in government programs for removing erosive lands from production have different consequences on program objectives. Bid pool allocation is one of the three discretionary factors in implementing the CRP that the U.S. Department of Agriculture Secretary may modify any time prior to a sign-up period. Dicks et al. (1987) concluded that using the largest possible big pool size (a national pool) provides the best achievement of a single objective goal, such as to minimize rental costs, maximize erosion reduction, or maximize crop control. State or substate bid pools tend to distribute CRP acres across the Nation, but at a loss of the single objective goal (Dicks et al. 1987).

Different strategies in government programs will also have different consequences on program participation across the United States. Bidding land out of production without regard to its erodibility reduces program crop production in the Southern Plains most heavily (Grano et al. 1985) (table 6). However, if the pattern of diversion payments realized in past programs was followed, the Northern Plains is more heavily affected. If the focus shifts from per acre profitability as the basis for including land in cropland retirement programs to the sole objective of reducing soil erosion, the Great Plains region is less affected than other regions. More erosion on a per acre basis occurs in the Corn Belt region. Even though the Great Plains has a greater than proportionate share of highly erosive cropland, the amount of erosion per acre is small when compared to soil losses per acre in other regions. The first strategy shown in table 6 is now being

implemented. Thus, the CRP may serve to stem the tide of increasing erosion levels within the Great Plains even though, at the national level, the objective of reducing soil erosion may not be optimized.

Future Land Use

Projections for the Great Plains

The impact of the CRP must be evaluated against other potential land use changes, and how those changes are implemented across the landscape. Projections of future resource production offer a quantitative way to assess whether our resources will meet future needs, given underlying assumptions. Projections are made with a set of assumptions about technology growth, export demand, agricultural management, and assume constant prices and stability in other aspects of the production environment (USDA Soil Conservation Service 1987).

Incorporating recent trends in the agricultural sector, economy and recent legislation, projections made by the Soil Conservation Service in the Second Resources Conservation Act (RCA) Appraisal suggest that significant readjustments in cropland will occur (USDA Soil Conservation Service 1987). Less than 40% of the available cropland in the Northern Plains, the Southern Plains and the Mountain States is projected to be in production by the year 2000 (fig. 8). This implies that 60% of the available cropland, a number five times greater than the potential acres in the CRP, would not be needed to supply the demands for crop production. These Great Plains acres could sit idle, move into set-aside programs, or convert to alternative land uses which would bring a higher investment, such as urbanland (USDA Soil Conservation Service 1987).

These projections are based on several assumptions concerning land use shifts. Cropland with the lowest profit per acre was identified as those acres which would be removed from crop production to reduce excess capacity and to meet the FSA Conservation Compliance provisions. Few conservation measures mitigate wind erosion, notably highest in the Great Plains. Sheet and rill erosion per acre are greater in other regions (notably, the Corn Belt), but attacking erosion by reducing acreage with the smallest profit margin per acre means that cropland in the Great Plains comes out of production. The consumer demand for less meat and a leaner meat product lowers the demand for feed-grains. Reduced export projections also place less demand for cropland.

The potential for population growth in the Second RCA Appraisal projections reflects the current population locations and greatest densities. By 2030, population in the Northern Plains was projected to be 9% less than the 1990 population. The situation was much different in the Southern Plains where the

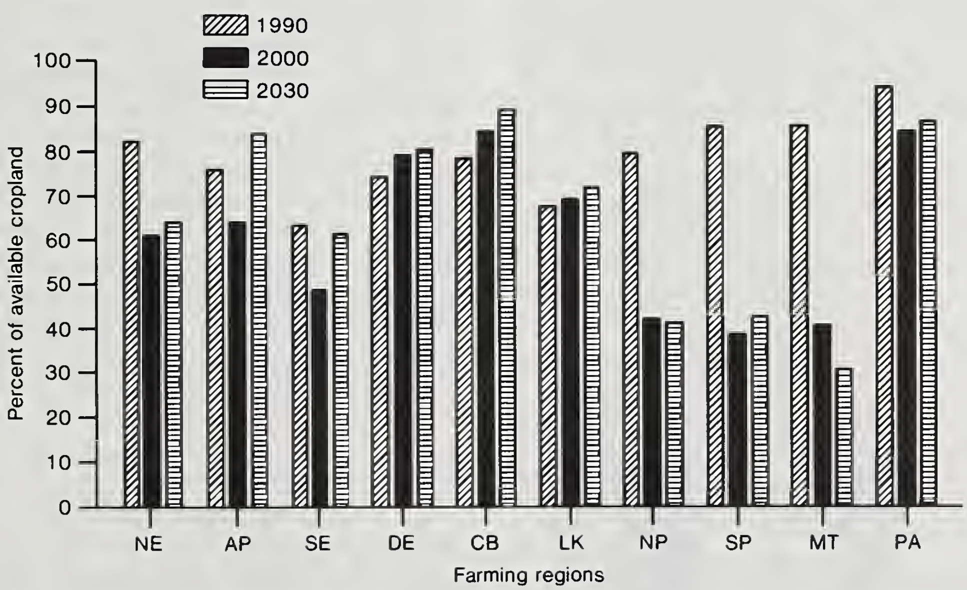

Figure 8.--U.S. Department of Agriculture projected cropland in farming regions in the United States for 1990, 2000, and 2030 (after USDA SCS 1987). Farming regions are defined as: NE (Northeast) includes the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont; AP (Appalachia) includes Kentucky, North Carolina, Tennessee, Virginia, and West Virginia; SE (Southeast) includes Alabama, Florida, Georgia, and South Carolina; DE (Delta States) includes Arkansas, Louisiana, and Mississippi; CB (Corn Belt) includes Illinois, Indiana, Iowa, Missouri, and Ohio; LK (Lake States) includes Michigan, Minnesota, and Wisconsin; NP (Northern Plains) includes Kansas, Nebraska, North Dakota, and South Dakota; SP (Southern Plains) includes Oklahoma, and Texas; MT (Mountain States) includes Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming; PA (Pacific) includes California, Oregon, and Washington.

population was projected to grow approximately 67% by 2030. The Mountain region was projected to double in population by 2030. The United States was projected to grow 22% by 2030.

These population growth estimates presume related land use conversions to non-agricultural land uses (fig. 9). By 2030, a 83% increase over the 1982 inventory of nonagricultural land was projected for the Southern Plains, a 33% increase in the Mountain States, and only a 7% increase in the Northern Plains. These urbanized acres far outweigh the currently contracted CRP acres, and could equal the potential maximum acres in the CRP program for the Great Plains.

Implications to the Pattern of Land Use

The pattern of land use in the Great Plains has changed and will continue to change. Determining the future pattern of land use on the Great Plains is a difficult task. Clearly, shifts in crop production and cropland set-aside programs will affect the pattern of land use and changes in this pattern of land use will affect other resources such as wildlife.

The impact of the RCA projected increase in non-agricultural land uses will depend on how it is distributed across the landscape. Approximately 20% of all cropland within the U.S. occurs within counties classified as Standard Metropolitan Statistical Areas (SMSA) (Gustafson and Bills 1984). Lessinger (1987) discussed the potential areas for population growth and described the area just outside of the urban commuting zone as most likely to exhibit a large growth in the future. If this area was described as those counties that are adjacent to a SMSA county and that have an urban population (residing in incorporated and

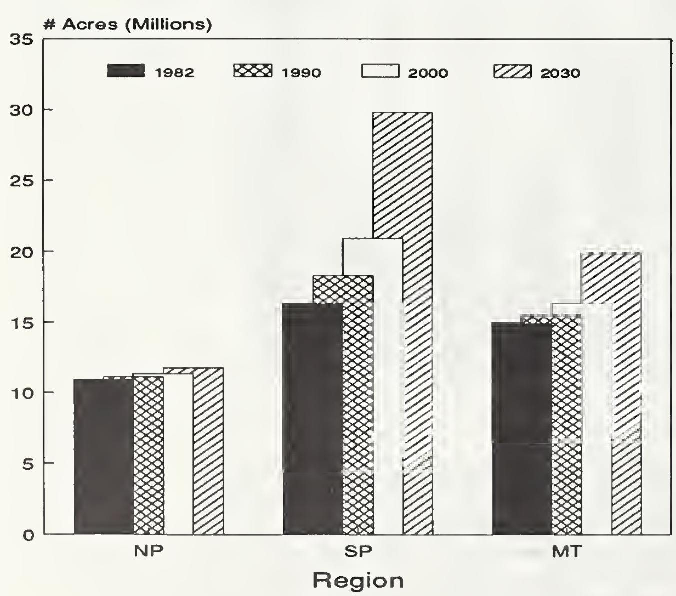

Figure 9.-- U.S. Department of Agriculture projected nonagricultural acreage for 1990, 2000 and 2030 in three subregions of the Great Plains: Northern Plains (NP), Southern Plains (SP), and Mountain states (MT) (after USDA SCS 1987). The subregions are as defined in the text.

unincorporated cities and towns) of 2,500 to 50,000, then approximately 46% of the Nation's cropland occurs within this potential growth area and the SMSA counties (Gustafson and Bills 1984). Within the Great Plains, the only areas likely to see this growth outside the commuting zone are areas surrounding urban centers in Oklahoma and Texas. The dramatic increases in the small size beef operations in these states may foster a residential encroachment of rural areas. Obviously, population growth in the areas which currently contain 46% of the nation's cropland imply a stronger demand for the remaining 54% of cropland occurring in more rural areas.

The consequences of the projected idle cropland were not specified in the Appraisal analysis. Acres in cropland could be idled in a short- or long-term government programs. Past crop acreage control programs have returned large land areas to native or herbaceous vegetation with observable impacts on bird and mammal populations. The increase and decrease in pheasant numbers in South Dakota were significantly related to Soil Bank acres (Erickson and Wiebe 1973). Although farmers in South Dakota had placed 3 million acres of wheat and feed-grain land in annual set-aside retirement in 1972, twice the South Dakota Soil Bank acreage, pheasant numbers did not reach the high population levels seen during the Soil Bank. Of 8,106 ac. surveyed, over 65% of the retired cropland acres were without vegetative cover (Erickson and Wiebe 1973). In study examining pheasant populations in Minnesota, Nebraska, North Dakota, and South Dakota, Schrader (1960) reported that pheasant rates of increase were greater in counties where more than 5% of the cropland was retired into permanent vegetative cover.

The short-term nature, either 1 year or 10 years, of acreage control programs does not allow for the development of the potential natural community, thus favoring animal species that are associated with early successional stages. Once the contract period ended, most of the Soil Bank acres were plowed under (Bartlett and Trock 1987). And, as was shown above, cropland fallow, no vegetative cover, has been used to meet crop set-aside requirement. Thus, the ultimate use, with or without vegetative cover, the length of the contract period, and the relationship of the set-aside land to the total land use in the area affect the impact government programs have on wildlife.

The projected idle cropland could be converted into another use, such as grazing or urbanland. Conversion of cropland to range or pasture might reverse the trend of increased fragmentation of natural communities whereas conversion to urbanland would accentuate this trend (Brady, in press). Conversion of cropland to permanent vegetative cover has the beneficial effects of providing food, cover, and shelter for some wildlife species. Wild turkey populations can benefit from land use practices such as rotation grazing systems, and deferred pastures. However, smaller farms and ranches in Texas, particularly under the economic conditions of the 1970's, were dependent on intensive land use and could not afford the habitat management programs on larger ranches (Gore 1973).

The Appraisal projections indicated regional shifts in the land used in crop production (fig. 8). Incorporated into this

projection was the Conservation Compliance measure of FSA. This subtitle requires that farms with highly erosive land engage in conservation farming practices on lands remaining in crop production as a condition of eligibility for participation in commodity programs. The definitions of conservation farming practices are still evolving, as are the rules for the kinds of land for which conservation plans must be developed (Dicks and Reichelderfer 1987).

Given the market price and cost conditions facing producers of major field crops, participation in commodity programs poses a strong financial incentive to develop conservation plans. A study of effects of conservation compliance provisions for a representative cotton farm in the Southern High Plains of Texas found that the farmer has no choice but to participate in government programs (Lippke et al. 1986). Without participation, the typical farm studied could not be expected to survive for five years. Continuation of the commodity program, but without the conservation compliance provisions, would give the farm a very good chance of survival. Farms with light soils, for which conservation plans include establishing windstrips, have their chances for survival greatly reduced. In general, required conservation compliance provisions were found to threaten the livelihood of such farms. At the same time, the commodity programs are necessary to keep the farms financially solvent.

The definition of conservation practices will impact other resources besides soil erosion. While nesting cover could be maintained by chemical fallowing on cropland (Benson 1977), this practice may also create problems for water quality or native fauna. The commonly used contact herbicide, paraquat, has been shown to increase mortality and impair growth in mallard embryos when applied at field application rates (Rodgers 1983). The impacts on non-targeted species are greater under the increasing use of broad spectrum chemicals (National Academy of Science 1982). The advantage of the pesticides currently in use is their relatively short half-life, although the initial toxicity on native fauna may be great (National Academy of Science 1982). In a recent study of no-till winter wheat impacts on nesting ducks, Duebbert and Kantrud (1987) reported no pesticide-related mortality with no-till. Clearly, the debate is not over.

Conclusions

Environmental, ecological, and economic factors affect the distribution and success of government crop programs within the Great Plains and across the nation. Great Plains cropland is removed from production because it has the lowest profit margin per acre and much variability of returns. Single objective programs, such as soil conservation, are ineffectively served by retiring Great Plains cropland as soil erosion is often greater in other regions of the nation. Within a region such as the Great Plains, the distribution of acres in a set- aside program, such as the CRP, affects soil erosion level and wildlife habitat. Long-term (10-year) diversions have greater potential for improving wildlife habitat than do the annual diversions and associated conservation compliance measures. An evaluation of the CRP for wildlife requires not only an examination of the planting, but of the land use within which the plantings are set. There are 12.9 million acres of the Great Plains in CRP now -- projected to go to 20 million. Five times this amount of cropland is projected to be out of production in the Great Plains by 2000. This potential shift in land use could overwhelm any impact the CRP acres would have in the Great Plains.

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A Prospectus for Research Needs Created by Passage of the Conservation Reserve Program

John E. Mitchell and Gary R. Evans[1]

Abstract.--The CRP will result in the payment of billions of dollars to convert highly erodible land to a permanent vegetative cover. For the Program to succeed, changes in land use must remain in place after the 10-year payment period ends. This paper outlines research needs to aid in reaching towards such a goal.

Soil erosion is recognized as a major problem that threatens food production on a global scale and results in profound environmental difficulties (Mabbutt 1980). In the United States, food production is not presently limiting; nonetheless, potential productivity has been declining at an alarming rate due to soil erosion (Crosson 1985). Besides reducing productivity, soil erosion causes expensive off-site environmental disturbances to industry, agriculture and wildlife (Piemental et al. 1987).

The costs to society of farming highly erodible cropland are expressed primarily in terms of off-site effects, and these sum to billions of dollars annually (Clark 1985). Therefore, the Conservation Reserve Program (CRP), a provision of the Food Security Act (FSA) of 1985 and described earlier in these Proceedings, may represent a logical societal investment in the long term. It is not, however, the first attempt by the federal government to control erosion in such a manner.

The CRP is, in some ways, commensurable with the Soil Bank of the late 1950s and 1960s, which contained its own conservation reserve program. The Soil Bank, authorized in the Agricultural Act of 1956, was established more to adjust supplies of agricultural commodities than to encourage soil conservation practices (Held and Clawson 1965), and land did not have to be highly erodible to qualify. However, farmers could participate in the conservation reserve provisions of the Act by setting land aside. Many of the practices were identical to those now being implemented under the CRP.

During the Soil Bank era, USDA paid $2.6 billion, amounting to nearly $9 billion in 1987 dollars, to subsidize farmers for converting cropland to permanent grass or tree cover. At its zenith in 1960, contracts covered 28.6 million acres under the program. Supposedly, this acreage was out of crop production to stay; however, such an outcome, unfortunately, did not occur. After the last contracts expired in 1972, most land seeded to grass went back into grain production during the agricultural upturn and return to more traditional price support programs that followed (Rasmussen 1982).

Land converted to permanent cover under the CRP is, ostensibly, less likely to revert to annual crop production again because of the conservation compliance provisions of the 1985 FSA. To do so without an approved conservation plan would deny farmers eligibility for other USDA commodity support programs. Nonetheless, when information germane to various management alternatives is lacking, farmers cannot be expected to make the decisions, rationale or not, envisioned by the authors of the Farm Bill.

If a large proportion of the land in the CRP does go back into annual cropping after the 10-year rental period, the direct cost to the government for the Program's failure will be substantial. Outlays are easily expected to exceed $5 billion over the first 5 years, according to some observers.[2] These costs could escalate even more if average rental payments increase as less marginal lands are included in the Program to reach acreage goals. Therefore, a high priority should be placed upon finding ways to maintain these highly erodible lands under permanent cover.

Policy makers will be primarily responsible for creating conditions conducive to maintaining land under permanent cover of grass or trees after the 10-year rental payments end. To make informed decisions, they need to understand the economic and ecological ramifications of these land conversions on all levels of society within the United States. Such knowledge will allow them to (1) recommend possible changes in existing legislation and regulations pertaining to the CRP and (2) prop-

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erly educate and inform participants and the general public about the Program.

The purpose of this paper is to briefly describe some of the gaps within the knowledge base available to agricultural policy makers and propose a research strategy for filling those gaps where knowledge is most urgently needed.

Knowledge Gaps

Ecology

Successional dynamics of natural communities have been studied in the Great Plains for more than 75 years (Shantz 1923). However, models of natural succession do not adequately explain what happens after grain fields are seeded to perennial grass (Bement et al. 1965). For example, Wilson and Briske (1979) found that blue grama *(Bouteloua gracilis)* could not be reestablished on some sites it dominated previously unless the soil remained moist during critical periods of seedling establishment. Such climatic conditions occur with extremely low frequency, and do not fit statistical parameters associated with the initial floristics model commonly used to interpret natural secondary succession.

During the soil bank and dust bowl eras, millions of acres of cropland were planted to grass. Some of these pastures remain in place, including lands purchased by the federal government and placed within the national grassland system. Consequently, an excellent opportunity exists to study successional dynamics of seeded plant communities by evaluating these old fields. In some cases, however, it may be difficult to retrieve the data necessary to determine initial conditions.

The successful establishment of perennial grass on cropland is a risky undertaking in the Great Plains. Some factors, such as weather and insect outbreaks, cannot be mitigated; however, recent advances in seeding technology have lessened the risk considerably (USDA Forest Service 1982). Seeding trials have provided a myriad of data on the suitability of different species and cultivars throughout the region (McGinnies et al. 1983, Eck and Sims 1984).

Seedbed preparation techniques, on the other hand, comprise an area of relative uncertainty (Hart and Dean 1986). In the Great Plains, a mulch of some kind is needed to retard wind erosion, retain soil water and moderate soil temperature (Vallentine 1971), but specific requirements based on research findings are generally lacking. Also, where established procedures are known, they frequently are not followed or are modified without a sound ecological basis.[3] Consequently, criteria for approved seeding plans under CRP vary among states and areas within states. For example, the phytotoxic effects of allelopathic agents associated with wheat stubble on germination and growth (Guenzi and McCalla 1962) provide the basis for restricting its use as a cover crop in some areas. However, definitive quantitative research has not been conducted to describe causal relations and limitations of these secondary plant products under actual field conditions. Treatment effects have been too difficult to isolate in complex soil-plant systems (Mandava 1985).

The CRP provides opportunities for the development of wildlife habitat. Although wildlife biologists know a great deal about habitat creation and improvement (Yoakum et al. 1980), additional research is needed. Farmers with small holdings may find that management practices in surrounding areas have a larger or controlling influence on wildlife populations than those they implement. As patches of habitat suitable for a given wildlife species become more dense, their synergistic effect may be substantial. The study of spatially dynamic systems will require new theory or innovative adaptation of existing theory. For example, foresters have recently looked at the minimum critical size of ecosystems (Burgess and Sharpe 1981) using MacArthur and Wilson's (1967) theory of island biogeography, a concept which could have application in wildlife management.

Expanded research is needed to evaluate advances in livestock grazing systems in relation to wildlife habitat quality on the High Plains. Historically, cattle have been managed on the basis of continuous grazing systems because various rotation systems were presumed to be ineffectual in improving range condition or animal performance (Herbel 1971). During the past decade, however, interest in short duration grazing systems has proliferated along the Great Plains (Heitschmidt et al. 1982, Kirby and Parman 1986). Although a few workers have reported how grazing systems affect a single upland game species (Hammerquist-Wilson and Crawford 1981), information remains seriously lacking.

Shelterbelts may also be planted on lands under provisions of the CRP. On the Great Plains, their most common observed use is for protection of farmsteads, even though they have been shown to reduce soil erosion, enhance crop production, provide wildlife habitat, and manage snowdrift location (Tinus 1976). To date, only a few hundred acres have been devoted to windbreaks under CRP, a fact that serves as a barometer of their perceived net value to those entering the Program. This disparity between actual and perceived value must logically result from a lack of available information. Unfortunately, research into establishment, management, and renovation of shelterbelts has decreased at just the time it may have been needed most.

A great deal of research has been conducted on soil losses from land under various climatological, physiographic, and management alternatives (Wischmeier and Smith 1978), including rangeland (Blackburn 1980). However, additional research is needed if watershed models are expected to accurately predict actual erosion from rangeland (Foster et al. 1981). Information on soil loss rates from reclaimed cropland is necessary if policy makers are to monitor how successfully the CRP actually reduces erosion.

At the watershed level, little is known about the effects of trapping windblown soil from adjacent fields on rangeland.

[3]Personal communication from Pat O. Currie, Research Leader, USDA-ARS Livestock and Range Research Station, Miles City, Mont.

Bartling (1987) showed a negative correlation between depth of deposited loess and blue grama production, but suggested other factors, such as increased temperature or high levels of soil phosphorus, may be causal. In addition, the role of grasslands as a possible depository and reservoir for vectors, insects and windblown pathogens has received no substantive research.

Economics and Sociology

Much of the ecological and physiological research dealing with functional knowledge gaps has not considered costs of their associated management practices. Although products of basic research cannot be limited by economic viability, applied research must be designed so that both costs and benefits can be assessed. New and innovative techniques, such as using drip irrigation systems to establish and maintain shelterbelts, will only be accepted if they can be shown to be cost effective.

The constraints of cost sharing provided by the CRP appear to be an area of concern for participating farmers (personal communication, attendees of this Symposium). Weed control provisions requiring repeated or expensive herbicide applications which are not adequately funded may result in failure to achieve desired objectives. On the other hand, future rental payments to new participants may become large enough to balance inadequate cost sharing as less marginal lands are included to reach acreage goals.

Any program that infuses large amounts of capital into a region can be expected to cause substantial perturbations to local and regional economies. The CRP is still too new to evaluate many of these effects, although some are discussed earlier in this Proceedings. Indication exists that capital is being distributed unequally in parts of Colorado and Texas, causing hardships within certain segments of local economies (Reichenberger 1987). The effect of CRP on qualified and non-qualified land prices has some potential to destabilize local economies. It should be imperative to at least monitor the economic structure of high- and moderate-impact areas using input-output models.

The CRP has already had an adverse effect on the winter forage supply in southeastern Colorado as a result of the loss of crop residue from fields placed into permanent grass cover and withdrawn from livestock use.[4] This will require ranchers to set aside pastures normally grazed during the growing season to compensate for this lost winter-early spring forage base. The economic ramifications of such a seasonal shift in forage supply have not been studied, but could have both short- and long-term significance.

In parts of Texas, farmers have learned that land managed for wildlife habitat can provide higher net income than solely from livestock or, at times, farming (Payne et al. 1987). However, conditions in Texas, such as a lack of public land, large areas suitable for big game habitat, and substantial amounts of discretionary income, are different from those across much of the Great Plains. Research on demand for wildlife and wildland recreation resources, including various kinds of wildlife, is needed by those assessing various options on CRP lands of all kinds, including shelterbelts (Dwyer 1980). Such information is needed to develop land use strategies involving wildlife as a resource base.

Besides knowing the economic effects of CRP during the period in which rental payments are being made, policy makers need prognoses of impacts on local economies after the contracts expire. At a regional level, expiration of CRP contracts could exert a substantial perturbation on the range livestock industry when millions of acres are potentially released for grazing or other forage uses including hay. The effects of this excess capacity in the range land base should be given close analysis or the stability of range livestock interests could be substantially perturbed.

Societal issues, although closely tied to economic considerations, form a unique area of research associated with the CRP. As previously discussed, policy makers failed to anticipate the response of farmers to the cessation of the Soil Bank Program; consequently, the federal government essentially lost several billion dollars. If those participating in the CRP are to be motivated towards continued land stewardship after the Program ends, their attitudes and behavior must be understood early enough to allow political decisions necessary to achieve such success (Napier and Forster 1982).

Socio-economic topics relating to the CRP are more than causal factors which affect agricultural policy. From a research perspective, the reverse is also true. That is, in order to adequately evaluate the range of opportunities open to policy makers in administering the 1985 FSA, the impacts of changes in macro-level agricultural policy on the CRP requires evaluation. Strategies to achieve national soil conservation objectives will depend greatly upon, and be limited by, the ideology of prevailing national policy. Hence, repercussions of possible changes in agricultural policy must be studied.

Proposed Research Strategy

Various state and Federal research agencies have demonstrated expertise in the topics outlined above. These include state universities and experiment stations; state fish and game and land management agencies; USDA Agricultural Research Service, Economic Research Service, and Forest Service; and USDI Fish and Wildlife Service. The USDA Soil Conservation Service (SCS), which is not a research agency, is the source of most information on past and present practices involving land use conversion from row crop agriculture to permanent cover, and would necessarily be involved in support of any major research program undertaken. Soil Conservation Districts, which have responsibilities for soil and water conservation at the local level, could provide practical input to research planning.

Professional societies also can provide leadership and assistance in a joint research program supporting CRP. For example,

[4]Personal communication from E. T. Bartlett, Dept. of Range Science, Colorado State Univ., Fort Collins.

the International Association of Fish and Wildlife Agencies has initiated a cooperative effort within its membership to monitor wildlife populations on some CRP lands. The Society for Range Management has formed a task force on the CRP to aid the SCS in undertaking a number of tasks at the request of the Chief of the SCS.

To be effective, a large scale research program should be placed under the auspices of a central organization. The USDA is probably best suited to establish priorities, acquire funding, and monitor research progress by participating organizations. It is not the purview of this paper to propose specific research topics or assignments; only to describe the need. If adequate funds are obtained to support the research needed to fill identified knowledge gaps, the return on investment will be considerable, perhaps exceeding 10 to 1. This assumes the need to reimplement another conservation reserve program for highly erodible lands that do return to crop production. If a research budget of $25 million resulted in keeping one-fourth of the lands presently under contract in permanent cover, the return would be on the order of 40 to 1. Such opportunities entreat a serious examination of the tradeoffs and strategies of a coordinated research program.

Conclusions

The dust bowl years of the 1930s provided a graphic lesson on the legacy of improper land management in the Great Plains. As a society, we should have realized the importance of soil as a basic resource which, once lost, cannot be replaced by any act of mankind. Despite the steps taken in erosion control on farmland, soil continues to be lost and in drought years, such as 1976-77, at rates comparable to that infamous period five decades ago (Lockeretz 1978). Even soil erosion from lands that are marginal for crop production has been shown to be highly detrimental in terms of off-site effects. Therefore, it is recognized that large areas of land now used for row crop agriculture should be taken out of grain production and put back under a permanent plant cover. Such an understanding justifies the recurring investments of public funds for land conversion, including the CRP. Given the risks associated with these programs in relation to the costs involved, research to fill ecological and socio-economic knowledge gaps affecting policy and management decisions is justified. A coordinated team effort, involving both federal and state agencies, as well as private interests, will be needed to establish and achieve specific research goals for the benefit of society.

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The Role of SCS and SRM in Implementing the Conservation Reserve Program

Wilson Scaling[1]

I commend all of you in the Society for Range Management's Colorado Section for your active role in addressing the future of lands going into the Conservation Reserve Program (CRP). SCS and other USDA agencies are very concerned about what happens to CRP land after the 10-year contract period. We are, of course, considering the conservation cover in plans that will help meet the long-term objectives of the producer. This kind of symposium is vital to ensure that the program works as well as possible -- that we are achieving our goals of soil and water conservation and of economic revitalization for American agriculture.

Your regional concerns are very important: The Great Plains region accounts for a large part of the CRP enrollment. And the range industry has a big stake in the outcome of the program. And, while we have regional concerns, we have to keep in mind a global perspective that Secretary Lyng talked about yesterday. We have to be mindful that agricultural production and related resource use in the United States are influenced by economic factors stemming from the agricultural and trade policies and activities of the world community more than at any other time in history.

Here at home, the CRP makes good sense in terms of economic strategy for agriculture -- indeed for all sectors of the economy:

- We're taking out of production the most highly erodible and most fragile lands, which also demand the most production inputs if cropped.
- Erosion reduction benefits of the CRP are cutting state and local public costs in terms of water quality, and cleanup of roads and waterways. And we still don't have the total picture as to these offsite benefits. But we suspect they are significant.
- Plant cover aids water conservation -- so critical to our Great plains watershed.
- Optimum plant cover put in place under the CRP stabilizes the soil, and benefits wildlife and the attractiveness of the landscape.

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- The program cuts commodity surpluses and helps agricultural production become market based.

The CRP can be a real boon to rural development in this country -- in the Great Plains and elsewhere:

- It can help preserve rural America, but not at the expense of agribusiness (that's why the 25% limit on a county's acreage allowed into the Reserve).
- And, it can help those farmers who are at the brink of disaster. One of the program's strengths is that putting land in the Reserve for 10 years can help those who are making the transition from agriculture to other enterprises.

I understand the deep concern surrounding the potential increase in grassland and its effects on the red meat industry and other parts of local economies in the Great Plains. But, I am also convinced that putting conservation cover on highly erodible and fragile lands is the best approach to long-term economic viability.

Here's what SCS is doing to make the best of CRP for the long term:

- We're giving the commitment to make it work.
- We're sitting down with other USDA agencies to discuss future policy affecting land coming out of the Reserve.
- We're providing technical expertise, as in the selection of plant materials. The Meeker Plant Materials Center here in Colorado is a prime example of federal, state, local, and private-sector cooperation.
- And, we're part of the Department's information and education team devoted to clarifying what CRP means to producers and communities. That effort includes reading out to limited-resource producers and Native Americans.

USDA cannot work alone and make the program a success. Our history shows that a strong cooperative partnership with state and local groups is what makes public conservation

programs the most effective and puts the most conservation on the ground. That is no less the case with the CRP.

I personally would like to see the Society for Range Management, and other professional organizations, play a major role in helping ranchers and farmers make wise decisions as to the disposition of CRP land after the 10-year contract period is up.

Here's my 7-point CRP challenge to the Society:

1. Help identify which land is best suited for use as range, and thus help to prevent adverse effects of the CRP on the range industry or on individual producers. Work with local organizations to determine which is most likely to be retained as range, based on (a) the quality of the land, (b) its proximity to established livestock facilities, and (c) the long-term management capabilities and interests of the operator.
2. Use your Society's resources to help educate and persuade operators with CRP land to make the correct decisions now so that the land will stay in grass after 10 years. For example, educate or re-educate grain producers who no longer produce grain but now have grass and range as a result of the CRP. Help them to establish, understand, manage, and maintain range for the highest economic return after CRP.
3. Help show the wildlife, water quality, and other benefits that result from permanent vegetative cover on these fragile, erodible lands.
4. Be a leader! Work closely with other organizations to build a consensus -- not just a group of single-interest decisions.
5. Encourage state and local hunting laws that allow CRP land to be maintained for hunting and thereby kept under protective cover.
6. Work with the Department and other agencies in identifying needed legislation, policy, and procedures to continue the benefits of the CRP on beyond 10 years.
7. And if you truly are interested in improving market conditions for the livestock industry, work with the Beef Council to dispel the 12 myths about red meat, which are:
    1. Beef is high in cholesterol.
    2. Beef is high in calories.
    3. Beef is high in saturated fat.
    4. The nutritional value of all meats is about the same.
    5. The nutritional value of the iron in beef is the same as the value of iron in vegetables.
    6. Beef is hard to digest.
    7. Diets recommended by health organizations should not include beef.
    8. Americans eat too much beef.
    9. Beef contains dangerous drug residues.
    10. Beef is frequently processed under unsanitary conditions.
    11. Beef has fallen out of favor with most Americans.
    12. Beef cattle use grain that could be used to feed the world's hungry.

    *Beef Industry Council

Thank you again for the leadership and initiative you've shown this week. I speak for all the SCS when I say that we appreciate your concern for the effectiveness of the CRP and for the well-being of the Great Plains.

Mitchell, John E., editor. 1988. Impacts of the Conservation Reserve Program in the Great Plains: Symposium Proceedings. [Denver, Colorado, September 16-18-1987] USDA Forest Service General Technical Report RM-158, 134 p. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.

The Conservation Reserve Program, created in the Food Security Act of 1985, will place up to 45 million acres of cropland under permanent cover for 10 years. At some cost, it provides opportunities to reduce soil erosion, enhance wildlife habitat, stimulate components of the farm economy, and reduce commodity surpluses.

Keywords: Grass seeding, plant establishment, windbreaks, wildlife, rangeland, cropland, wetland, range ecology, farm policy, land conversion, rural sociology, agricultural history.

Rocky Mountains

Southwest

Great Plains

U.S. Department of Agriculture
Forest Service

Rocky Mountain Forest and Range Experiment Station

The Rocky Mountain Station is one of eight regional experiment stations, plus the Forest Products Laboratory and the Washington Office Staff, that make up the Forest Service research organization.

RESEARCH FOCUS

Research programs at the Rocky Mountain Station are coordinated with area universities and with other institutions. Many studies are conducted on a cooperative basis to accelerate solutions to problems involving range, water, wildlife and fish habitat, human and community development, timber, recreation, protection, and multiresource evaluation.

RESEARCH LOCATIONS

Research Work Units of the Rocky Mountain Station are operated in cooperation with universities in the following cities:

Albuquerque, New Mexico
Flagstaff, Arizona
Fort Collins, Colorado*
Laramie, Wyoming
Lincoln, Nebraska
Rapid City, South Dakota
Tempe, Arizona

*Station Headquarters: 240 W. Prospect St., Fort Collins, CO 80526